Iron and Steel ENGINEER

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TO THE IRON AND STEEL
INDUSTRY SINCE 1907

MAY, 1959

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DETROIT

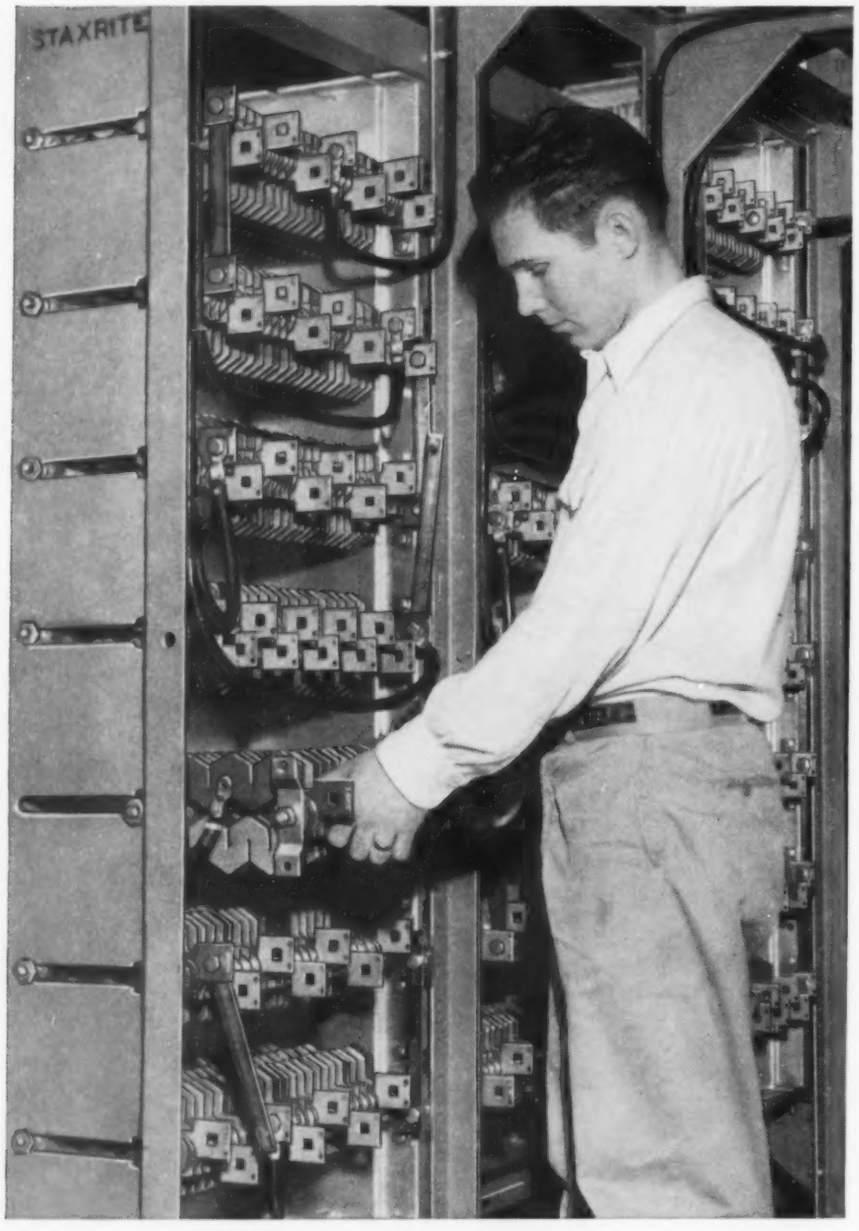
End product of tinning line leadership . . .

Wean designed and built the first full-width commercial electrolytic tinning line, and has been the leader in all significant technological advances made in this field. More than three-fourths of this country's tin plate is produced on Wean lines.

This is but one example of the partnership between Wean and the steel industry in the development of improved sheet, strip and tin plate processing techniques.

THE WEAN ENGINEERING COMPANY, INC. • WARREN • OHIO

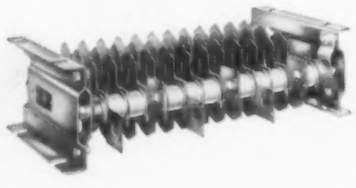
Complete non-breakable resistor banks . . .
factory assembled, wired and ready to go



Here is the very latest word in Mill Duty resistors . . . Cutler-Hammer's "draw-out" designed non-breakable mill duty resistors and Staxrite®, the multiple resistor mounting frame. Together these two units become a solid free-standing resistor bank that can be "custom-tailored" to meet your specific needs. Staxrite resistor frames, available in graduated sizes, will accommodate up to nine non-breakable resistor units. Add to this the optional feature of a terminal board and grid-to-terminal wiring and your resistor bank is ready for rapid installation. No more time-consuming box-to-box mounting. Costly on-the-job wiring is cut to a bare minimum. A Staxrite resistor bank saves valuable space too . . . it only requires the floor area of a single resistor box.

Notice how easily the "draw-out" designed resistor units slide in and out of position; this is a Cutler-Hammer exclusive. Each resistor unit is completely independent, and can be serviced or replaced by a spare unit without disturbing end frames, adjacent resistor units, or mounting members. "Draw-out" design will cut your "down-time" during maintenance and alterations. Enclosed resistor banks also available . . . added safety for your men and protection for the resistors. For further information, write Dept. J-232, Cutler-Hammer Inc., Milwaukee 1, Wis.

Cutler-Hammer's Non-breakable Mill Duty Resistors are the choice of Mill engineers everywhere



These extra rugged resistors were designed specifically for mill and crane applications where service is severe. Cutler-Hammer 11011 Mill Duty resistors are available in three standard widths and can be mounted independently or in a Staxrite mounting frame. Check these other important features of design and construction.

- Stamped chrome-steel grids
- Shock-proof
- Vibration-proof
- Corrosion-resistant
- Welded grid joints
- No pressure dependent grid contacts
- Staggered, projected terminals
- Welded grid-to-terminal joints
- Heavy duty mica insulators

CUTLER-HAMMER CONTROL C-H

CUTLER-HAMMER

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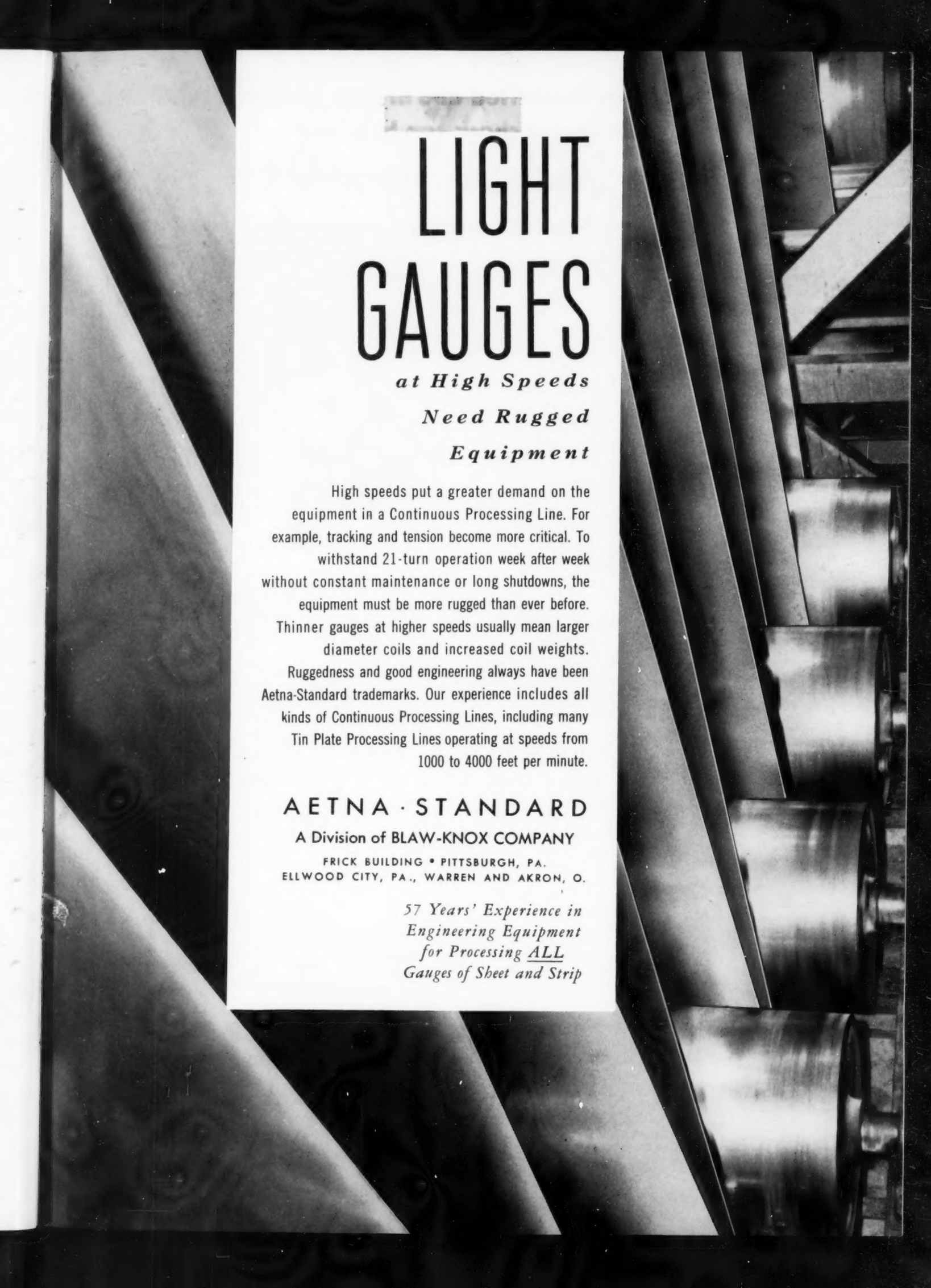

LIGHT GAUGES

at High Speeds Need Rugged Equipment

High speeds put a greater demand on the equipment in a Continuous Processing Line. For example, tracking and tension become more critical. To withstand 21-turn operation week after week without constant maintenance or long shutdowns, the equipment must be more rugged than ever before. Thinner gauges at higher speeds usually mean larger diameter coils and increased coil weights. Ruggedness and good engineering always have been Aetna-Standard trademarks. Our experience includes all kinds of Continuous Processing Lines, including many Tin Plate Processing Lines operating at speeds from 1000 to 4000 feet per minute.

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57 Years' Experience in Engineering Equipment for Processing ALL Gauges of Sheet and Strip

Before you buy babbitted and bronze bearings . . .
this 6-spot check can help you

pre-judge quality

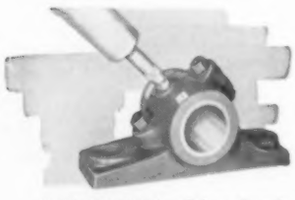
HOUSINGS are of durable cast gray iron . . . compact, exceptionally strong and rigid. No excess weight.

BASES are finished for close tolerance from base to center of bore—assure firm seating on supports.

BORES are finish-machined to close tolerances . . . assure concentricity, accurate fit on the shaft.

ENDS are finished to provide accurate bearing surface for collar or sprocket . . . reduce friction.

BOLT HOLES in base are slotted to permit easy adjustments for accurate shaft alignment.



LUBRICATION of bearing is provided through grooves and fitting in cap.

You'll find these LINK-BELT features in 15 types and more than 300 standard sizes

LOOK for these features when you buy babbitted and bronze bearing blocks . . . and you can be sure of long-lasting, free-rolling efficiency every time.

In addition to those illustrated, Link-Belt uses a heavy-duty babbitt or high-quality bronze—securely anchored in housing—for long bearing life. What's more, Link-Belt assures off-the-shelf delivery on more than 15 types and over 300 sizes of solid, split, gibbed or angle blocks for shaft sizes from ½ to 8 inches, plus related take-ups. And for special applications, bearings can be furnished with cast steel housings.

Link-Belt bearing blocks are carefully packed to assure factory-finish condition on delivery. Recessed decals identify bearing blocks by serial number and size . . . simplify ordering. Call your nearest Link-Belt office or authorized stock-carrying distributor. Refer to the yellow pages of your local phone directory.

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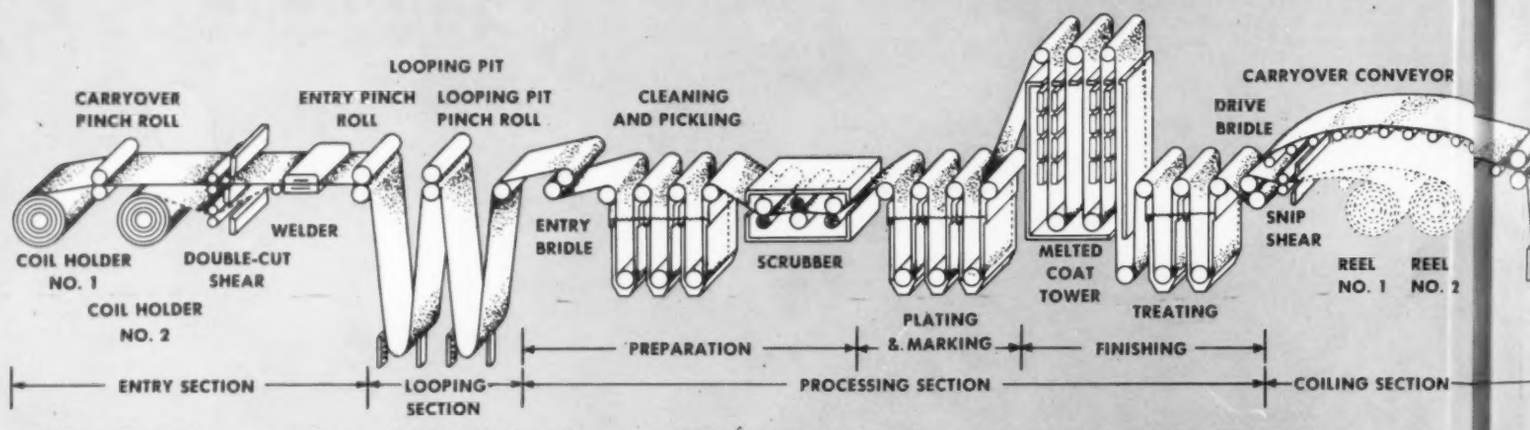
Over 80% of all FERROSTAN* TINNING LINES are CLARK



ENTRY SECTION. This section operates as an independent unit so it can be started and stopped while the rest of the line is running. Entire section can be accelerated to overspeed condition to replenish the loops. When loops are filled, speed is automatically reduced to match that of processing section.

LOOPING SECTION. Loops provide storage for strip during periods when entry section is stopped for coil changes, permitting processing section to run continuously. Multiple loops permit shallower looping pit, and can be synchronized to stay uniform. Modulated loop control provides stepless regulation of entry speed so strip is fed to processing section at constant speed.

PROCESSING SECTION. Plating, marking, melted coat and chemical treatment currents are accurately synchronized with line speed. Adjustable differential plating control can be provided to permit heavier tin plate deposit on one side of strip. Necessary torque and speed regulation is provided for individual motor drives on conductor, sink and deflector rolls. Overall line speed is accurately regulated by means of magnetic amplifiers.

COILING SECTION. Line shown permits optional type operation, either coiling or shearing. When coiling, control transfers from one reel to the other while line is running. Carryover conveyor is used only when shearing.

Continuous electrolytic tinning lines represent just about the most complicated electrical control problems to be found in any manufacturing process. From coil holders at entry end to recoilers—or classifier and piler—at exit end, line speeds and tension must be precisely regulated and coordinated with processing operations. Only with the most carefully engineered control system can the line be operated continuously at high speeds to produce the high uniform quality tinned strip demanded by the canning industry —No. 1 consumer of tin plate.

The Clark Controller Company, with its more than 30 years experience in specialized engineered control, and with electrical control its sole interest, is the leader in supplying the elaborate and complicated controls required by Ferrostan* tinning lines.

Shown above is a flow diagram of a typical Ferrostan* line, indicating the essential components and the complexity of the control required. This line provides both shearing and piling of tinned strip, and coiling. A number of lines, originally designed for only shearing and piling have recently added coiling—with Clark engineering the supplementary control.

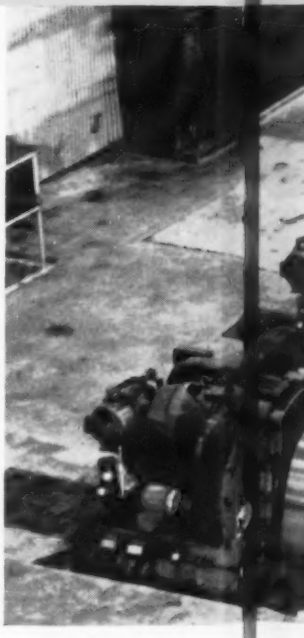
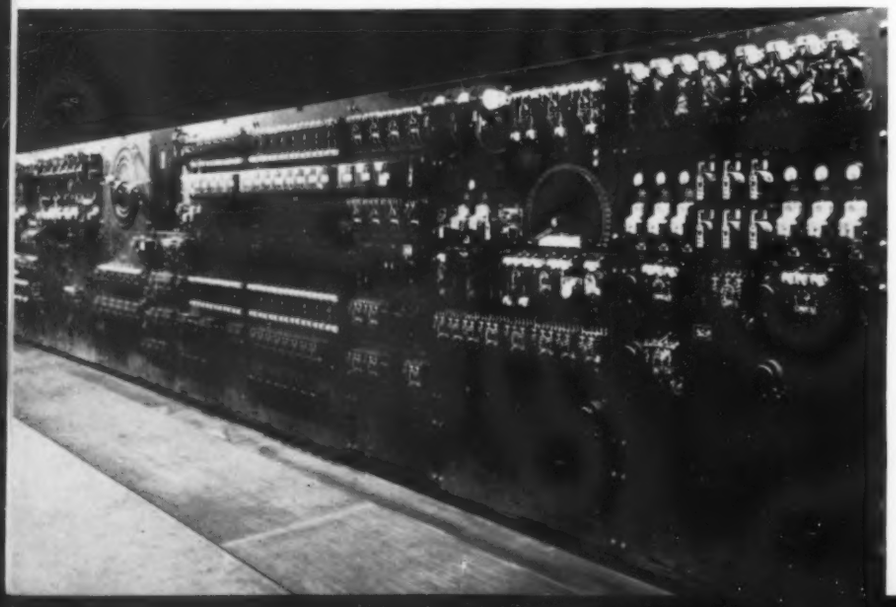
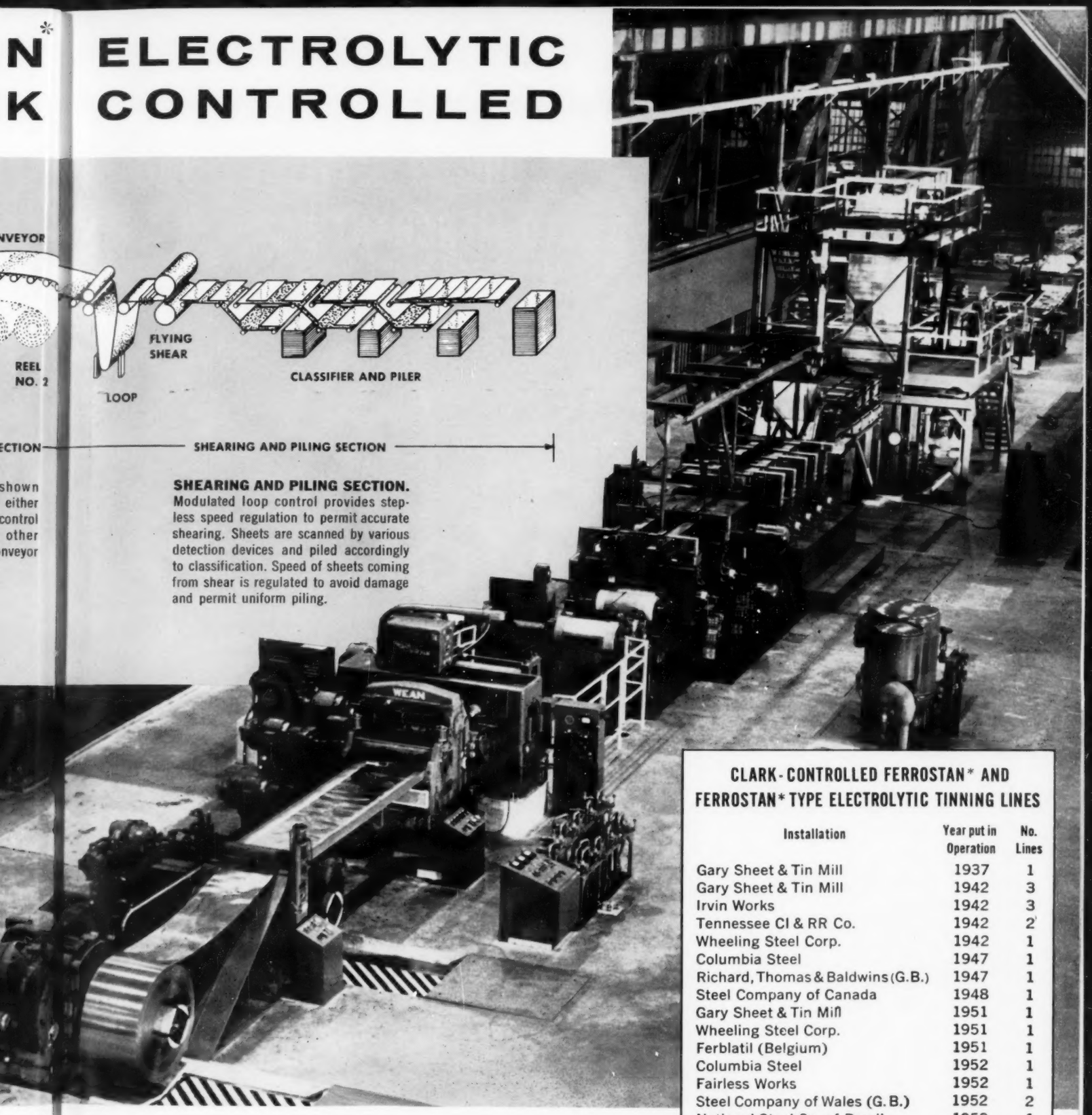


Photo Courtesy The Wean Engineering Company, Inc.



A portion of the main control panel for a Ferrostan* tinning line . . . In addition to tinning lines, Clark is a major supplier of essential control for all types of processing lines in the basic metal industries including rolling mills, pickling, slitting, shearing, annealing and galvanizing lines, as well as control for wire drawing, blast furnace charging, cranes and many other mill and material handling operations.

ELECTROLYTIC CONTROLLED



SHEARING AND PILING SECTION. Modulated loop control provides stepless speed regulation to permit accurate shearing. Sheets are scanned by various detection devices and piled accordingly to classification. Speed of sheets coming from shear is regulated to avoid damage and permit uniform piling.

Typical Ferrostan* electrolytic tinning line—completely equipped with Clark engineered control. Entry section in foreground shows coil holder, shear and welder. Looping pit is below floor level and not visible. Preparation and plating sections can be seen in front of melted-coat tower in upper right. Classifier and piler are in far background.

*Trade Mark - U. S. Steel Corp.

CLARK-CONTROLLED FERROSTAN* AND FERROSTAN* TYPE ELECTROLYTIC TINNING LINES

Installation	Year put in Operation	No. Lines
Gary Sheet & Tin Mill	1937	1
Gary Sheet & Tin Mill	1942	3
Irvin Works	1942	3
Tennessee CI & RR Co.	1942	2
Wheeling Steel Corp.	1942	1
Columbia Steel	1947	1
Richard, Thomas & Baldwins (G.B.)	1947	1
Steel Company of Canada	1948	1
Gary Sheet & Tin Mill	1951	1
Wheeling Steel Corp.	1951	1
Ferblatil (Belgium)	1951	1
Columbia Steel	1952	1
Fairless Works	1952	1
Steel Company of Wales (G.B.)	1952	2
National Steel Co. of Brazil	1953	1
Tennessee CI & RR Co.	1955	1
Toyo Kohan (Japan)	1955	1
Yawata (Japan)	1957	1
Altos Hornos de Mexico	1957	1
Cornigliano (Italy)	1957	1
Fuji (Japan)	1958	1
Yawata (Japan)	1958	1
Kaiser Steel Corp.	1958	1
	TOTAL	29

The **CLARK CONTROLLER** *Company*

Everything Under Control

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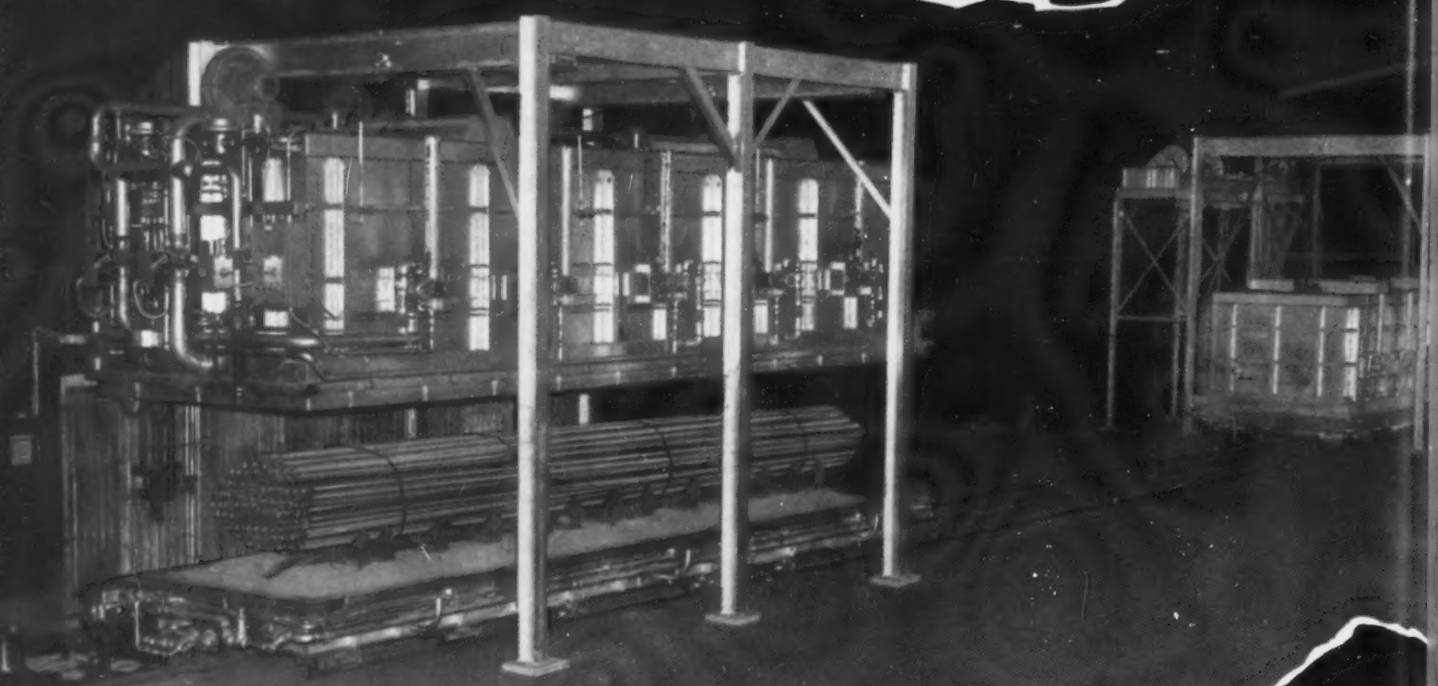
IN CANADA: CANADIAN CONTROLLERS LIMITED • MAIN OFFICES AND PLANT, TORONTO

Lee Wilson

...BRINGS BETTER CONTROL TO MERCHANT BAR ANNEALING



The finest control of merchant bar annealing yet known has been achieved with the new Lee Wilson Bar Annealing System, with multiple-zone control in the furnace and with radiant tube base heating with its control interlocked with the furnace zones.

These new furnaces process anneal, spheroidize and lamellar anneal to uniform physical properties because the heat is applied more uniformly and controlled with greater precision. Proper atmospheres protect against decarburization.

Shown above is the new Lee Wilson installation at a plant of a large Eastern producer of high carbon, alloy and stainless merchant bar and coils.

If annealing merchant bar, wire, rod, strip or sheet coil — steel, aluminum or brass — is part of your business, Lee Wilson has the furnace and experience to give you better results at reduced costs.

Lee Wilson ENGINEERING COMPANY, INC.

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ORIGINATORS AND LEADING PRODUCERS OF OPENED COIL AND SINGLE STACK FURNACES

a new concept in ship unloaders!

Dravo completes new type rope-operated man-trolley unloaders at Burnside, La.

A new type ship unloader was designed and built by Dravo for the Greater Baton Rouge Port Commission's bulk marine terminal on the Mississippi River at Burnside, La. Two of these machines operate on an 858-foot Dravo-built dock.

The new public terminal, operated by Ramsay, Scarlett & Co., Inc., is the largest facility for handling bulk cargo in the Gulf Coast area.

An entirely new concept in traveling ship unloaders, this unique, rope-operated, man-trolley design combines advantages of the conventional man-trolley unloader with the light-weight construction of rope-operated machines. The result is a highly efficient unit that reduces ship turn-around time to a minimum never before obtainable with a rope-operated unloader of comparable size.

All hoisting machinery is located in the structure's tower, greatly reducing the weight of the man-trolley. The bucket, which has a hoist speed of 540 feet per minute, is suspended from a ring-type turntable and can be rotated for more efficient digging under decks. Operators have an unobstructed view into either barges or ships' holds. The man-trolley can be racked back and forth along a 149-foot runway at 540 feet per minute.

The reeving system (patents applied for) of the new unloaders greatly reduces down time for bucket changing and rope replacement. Substantial savings are realized in rope costs, too, since a minimum of rope is wasted when replacing sections damaged by ships' hatch coamings.

Find out how Dravo's design and building know-how can help solve your bulk materials handling problems. Simply call us at Pittsburgh, Spalding 1-1200, or write to DRAVO CORPORATION, PITTSBURGH 25, PENNSYLVANIA.

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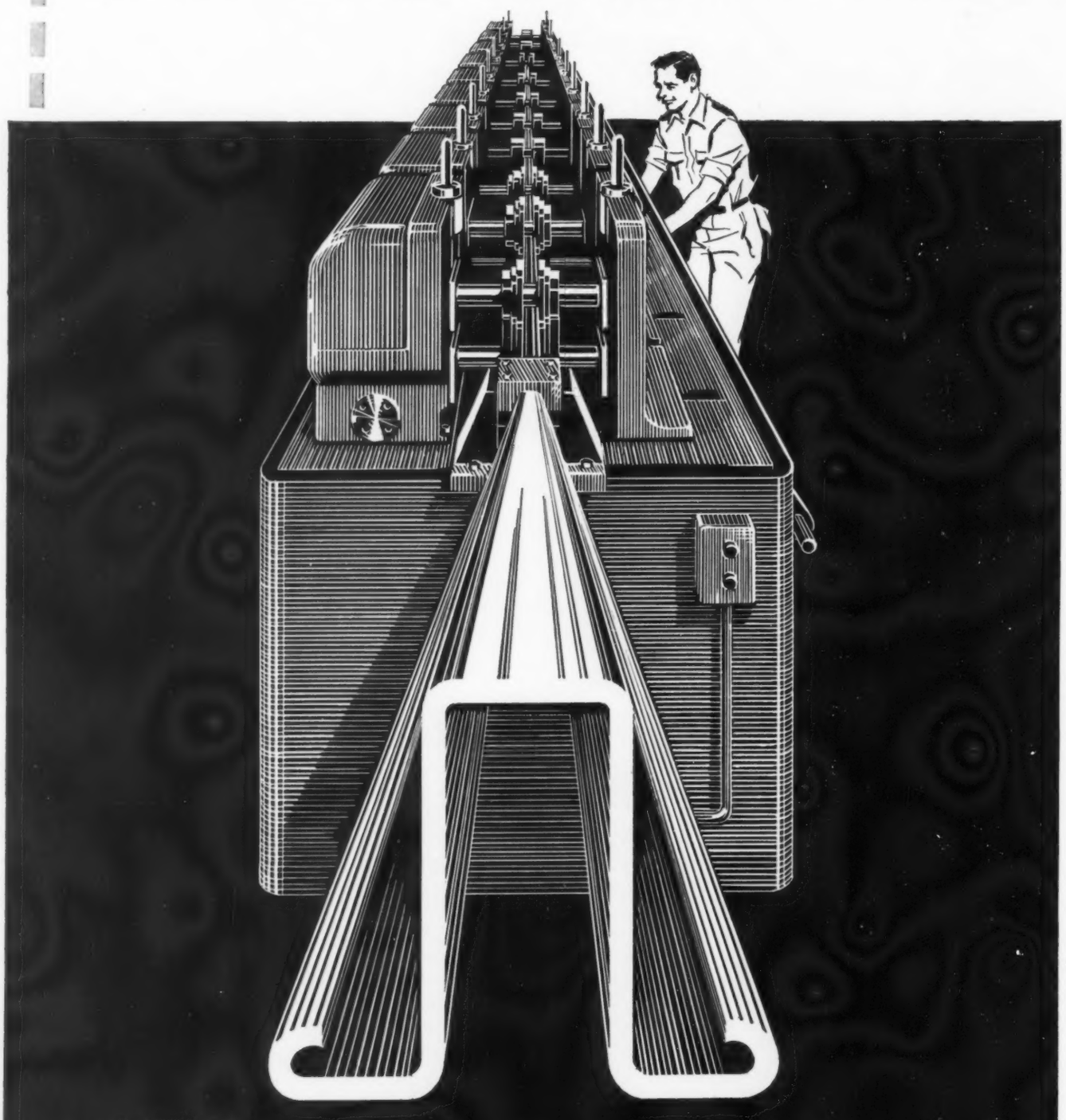

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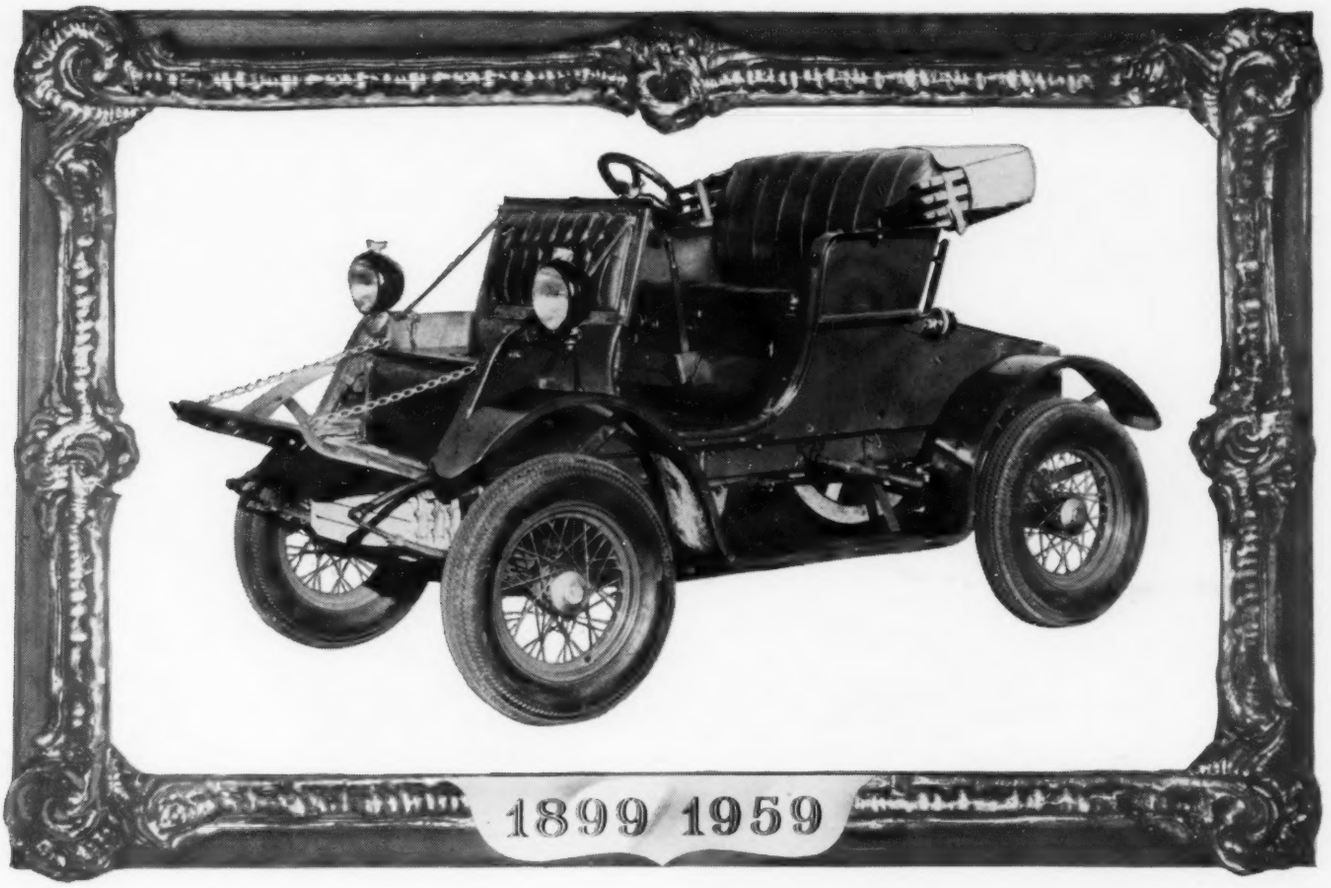


Everything's changed but the trademark on the bearings

BUILT by the St. Louis Motor Car Co. in 1899, this car was the first equipped with Timken® tapered roller bearings. It's still running. And today every make of American car but one uses Timken bearings. The things that the trademark "Timken" stands for haven't changed. It still means the highest quality, the best-known name in bearings, and the kind of service you can't get anywhere else. It means better performance with longer life and less maintenance in machine tools, steel mills, heavy construction machinery, farm implements and tractors —wherever wheels and shafts turn.

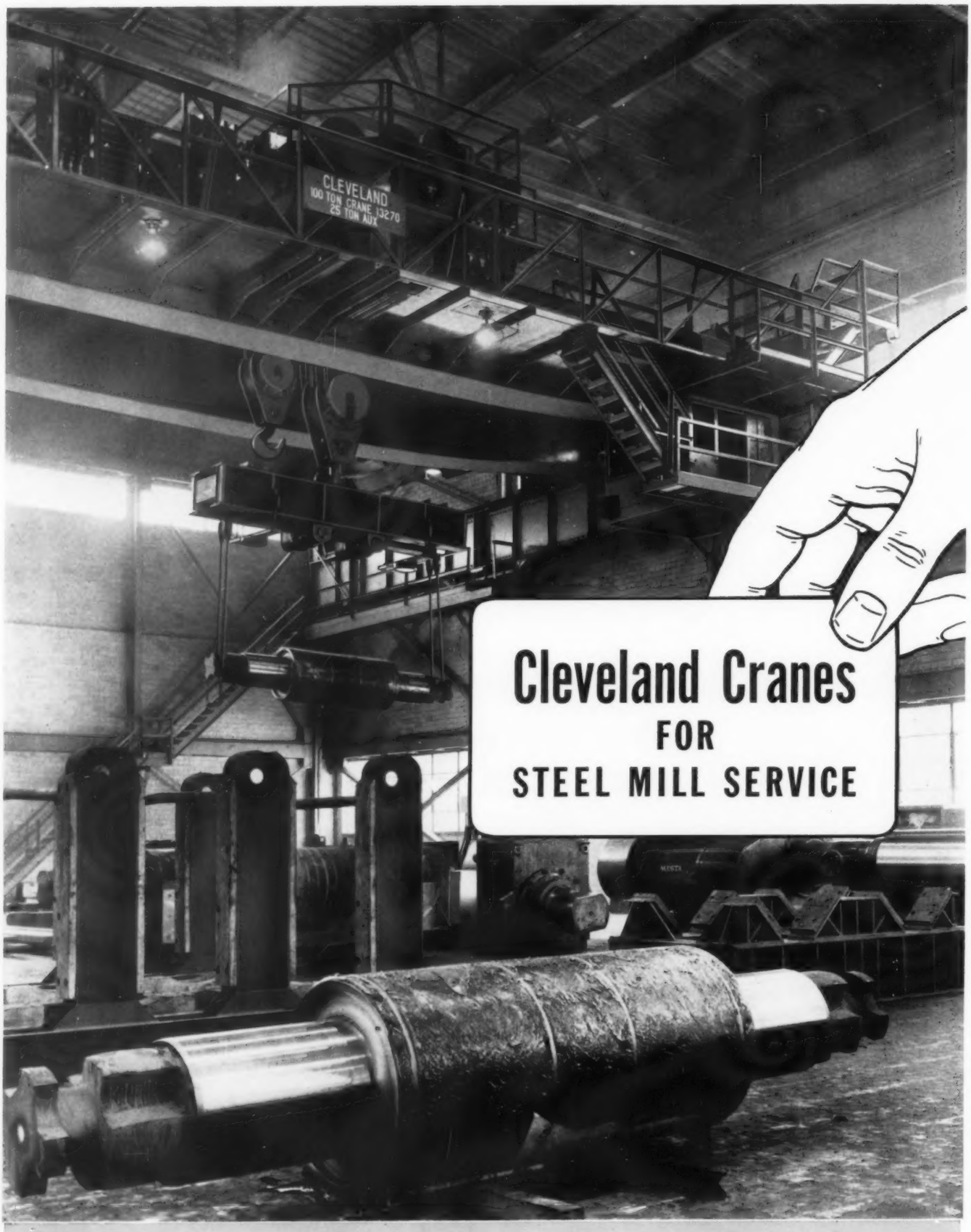
"Timken" is a registered trademark that identifies all products of The Timken Roller Bearing Company—tapered roller bearings, fine alloy steel bars, seamless steel tubing and removable rock bits.

It's to your advantage to remember that "Timken" is not a type of product. It's your assurance of the best in tapered roller bearings, fine alloy steels and removable rock bits. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO".

TAPERED ROLLER BEARINGS • REMOVABLE ROCK BITS • FINE ALLOY STEEL

TIMKEN®

first in quality for 60 years



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

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WICKLIFFE, OHIO

Crops *and* Shorts

△ March, a traditional month for setting records in the steel industry, held true to form this year. Steel production hit a new peak at 11,567,000 tons, a rate of 92.3 per cent of the capacity or 162.6 per cent of the 1947–49 average production. Blast furnaces also set a production record in March with 7,510,051 tons. Numerous company, plant and departmental records were set by various producers.

△ After exchanging letters asking for freezes on prices, wages, etc., the United Steel Workers and the industry have advanced the opening of their negotiations to May 5. It promises to be a hot session. As the bargaining begins, it would be well to remember that steel industry hourly earnings in various foreign countries that exported 1,700,000 tons of steel to the United States in 1958 are only 14 to 34 per cent of the U. S. rate—and employment costs in the U. S. already take 38½ per cent of industry's sales receipts.

△ There is a joke in Russia that the country's most successful inventor is Comrade Reguspatoff (Reg US Pat. Off).

△ According to the American Iron and Steel Institute the geographic center of steelmaking capacity in the United States has moved about 20 miles to the west in the past two years. It is now near Spencerville, in Allen County, Ohio.

△ In case you're interested, the inch is going to become 25.4 millimeters officially. It has been 25.400051 millimeters in the United States and 25.399956 in England.

△ Employment costs for hourly employees in the iron and steel industry hit a new high of $3.513 per hour worked in 1958, 9.2 per cent more than in 1957. This was made up of $2.787 per hour straight time plus more than 72 cents per hour for shift differentials, Sunday and overtime premium, holiday and vacation pay, and cost of insurance, pensions, supplemental unemployment benefits and social security. The second half of the vear, as a result of the July 1 increases averaged $3.598, 8½ cents over the full year average.

△ Sign on a Washington retail establishment: "Fire Sale! If you don't buy something quick, someone's gonna get fired."

△ Shortages in iron ore stocks resulting from the high rate of operations led to an early opening of the Lakes ore season. The first carrier cleared the locks on April 10, almost two weeks ahead of usual dates.

△ A correspondent says he prefers to hire only married men. Claims they are not in such a hurry to leave the office at five o'clock.

△Tonnages of the principal products shipped by the steel industry in 1958 were cold rolled sheets, 10,325,661 tons; hot rolled sheets, 6,291,266 tons; hot rolled bars, including light shapes 5,646,563 tons; plates, 5,268,420; and electrolytic tinplate, 5,040,190 tons.

△ The universal credit card situation continues to boil and stew. Some big restaurants have dropped credit card affiliations. Others are adding a percentage to items charged to cover the credit organization's fee. Still others are accepting the card as a credit reference and then billing the customer direct. As a result, the commission charges have begun to slide and now range between 4½ per cent and the old standard 7 per cent. And the field still looks green to some people. Travel agents are thinking about setting up a card of their own.

As We've said before, hotels, restaurants and similar businesses can't afford to pay out the credit commissions without raising prices. Adding a surcharge to items bought on credit seems a perfectly logical way of making the user of the service pay for it.

Personally, we still think Uncle Sam's folding money is the best credit reference, but the airlines are toying with what seems to be a good idea. They propose to set up their credit card, which is backed by a deposit with the airlines, as a general credit reference, but the billings would come directly from the concern making the charge. This would involve no commission.

△Wouldn't it be nice if we had as much fun when we're out as our wives think we do?

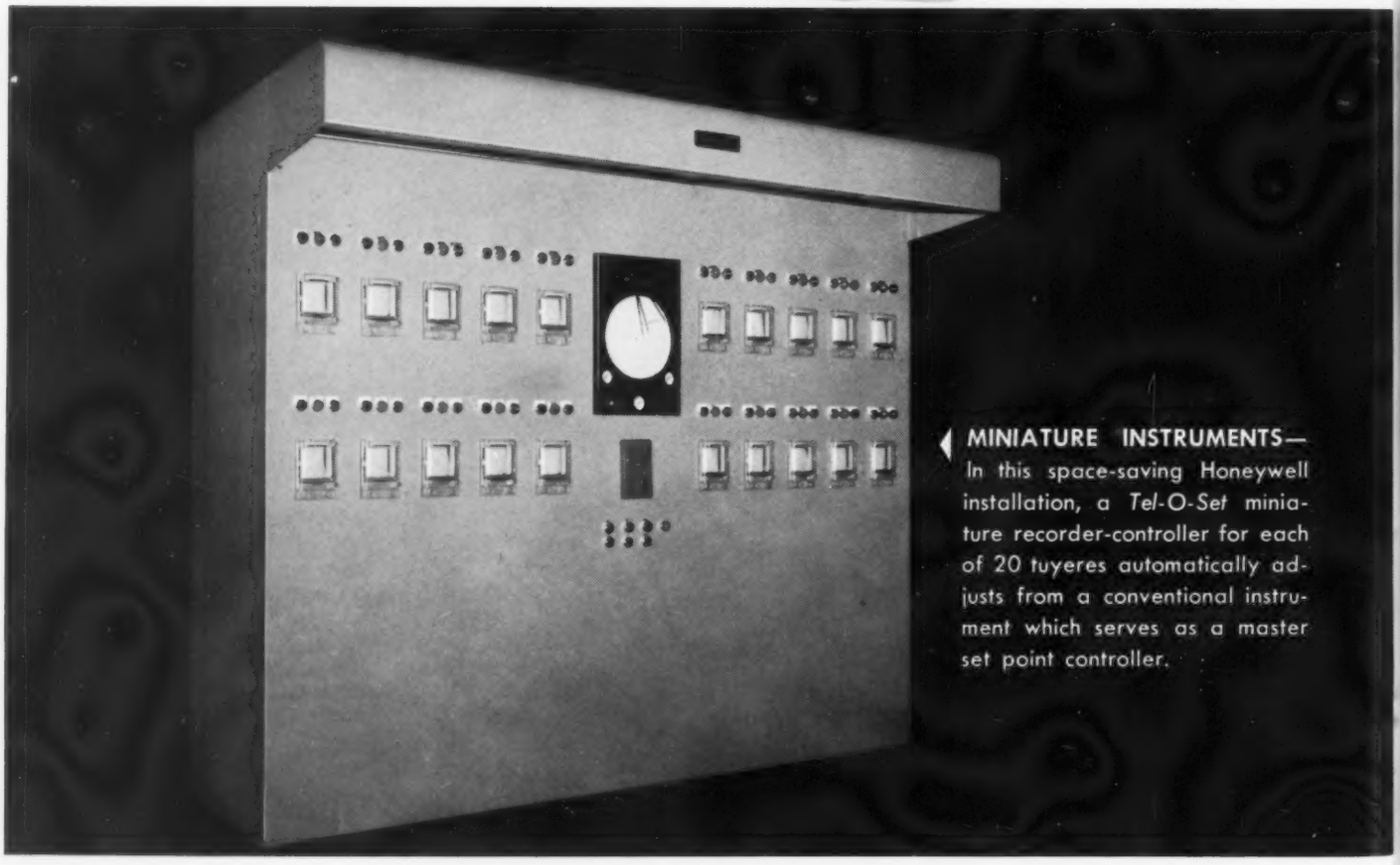
△ Sometimes it's hard to tell who wins a strike. Chrysler Corporation's automobile production suffered from the prolonged strike at Pittsburgh Plate Glass Company. Following settlement of the strike, Chrysler announced that it will convert two stamping plants to the fabrication of windshields, back lights, windows, etc. Eventually, it will produce about 50 per cent of its own glass needs. Who won that strike? And the 76-day Allis-Chalmers strike was settled on the terms offered by the company before walkout.

△ The 1958 accident frequency of 3.21 accidents per million man-hours was a new record low for the iron and steel industry. This is almost 42 per cent under the figure of ten years ago.

△ Why worry about growing old? When we stop growing older, we're dead.

△ It is reported that research activity, which in general declined sharply during the recession, is again picking up.

STABILIZE WIND



MINIATURE INSTRUMENTS— In this space-saving Honeywell installation, a *Tel-O-Set* miniature recorder-controller for each of 20 tuyeres automatically adjusts from a conventional instrument which serves as a master set point controller.

...with an automatic tuyere control system by Honeywell

Equalized control of tuyere flow helps give you better blast furnace stability. Honeywell instrumentation gives you that control . . . automatically, accurately, dependably.

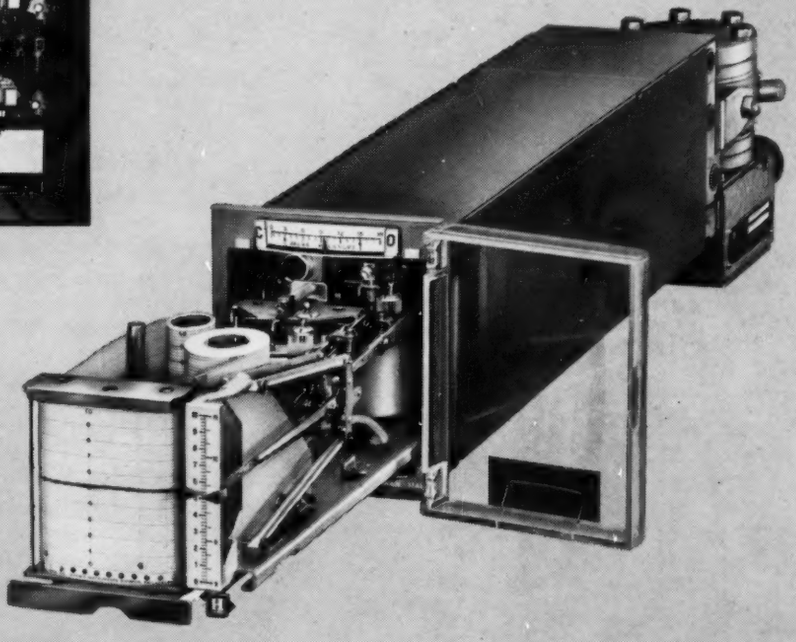
Honeywell control systems, custom-designed for your mill, proportion flow equally through each blast furnace tuyere to maintain uniform air distribution within the furnace. This stability gives you the economy that comes with efficient operation.

Each tuyere is controlled by a *Differential Converter* flow transmitter, a flow controller, valve and valve positioner. A master controller determines the correct set point and automatically adjusts each tuyere to the setting. Pressure loss is minimized because the system keeps valves open at the maximum allowable position for a given flow. After checks or casts, the master controller quickly recalculates the set point and maintains equal flow through all tuyeres, despite irregular resistance. Lags and dangerous pressure build-ups are eliminated.

Ask your nearby Honeywell field engineer for details on automatic tuyere control systems, or any steel mill instrumentation. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Phila. 44, Pa.

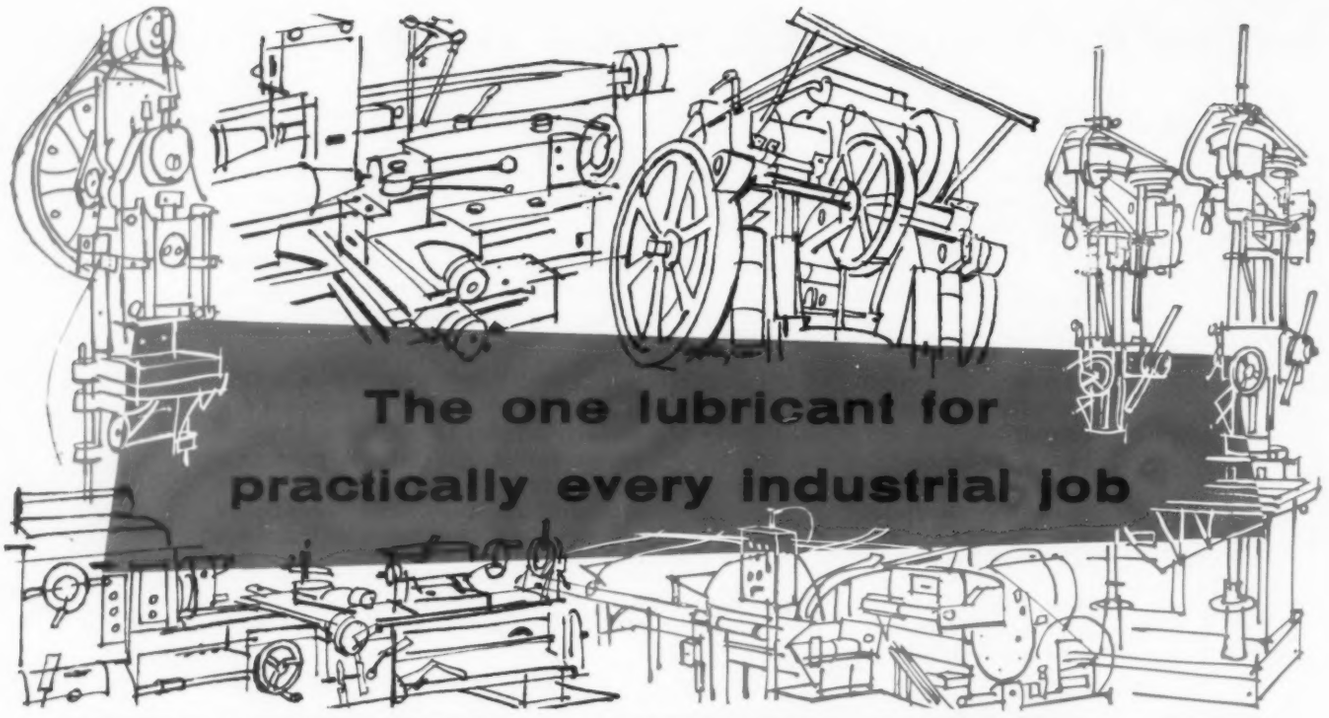
BACK-OF-PANEL VIEW gives some indication of the careful engineering that characterizes Honeywell control systems. Each panel is custom-designed to meet the requirements of a particular mill.



TEL-O-SET individual tuyere flow recorder-controller simultaneously records tuyere flow and valve position and also indicates master set point.

Honeywell

First in Control



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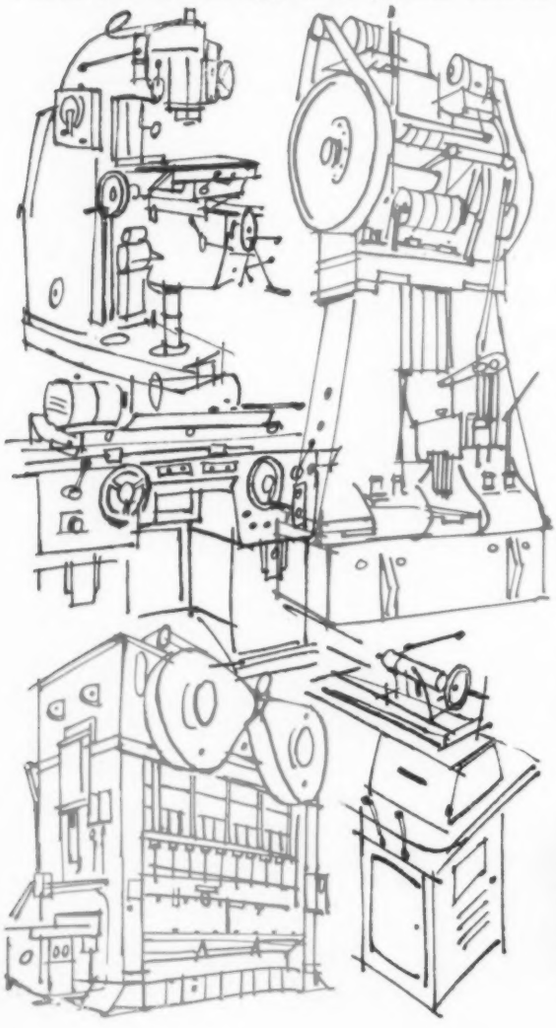

Atlantic Lubricant 54—an outstanding multi-purpose lubricant—assures:

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- **Reduced losses** from lubricating error
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Wheelabrator mechanical descaler for cleaning skelp.

Another example of Steel Industry Savings with Wheelabrator® Mechanical Descaling

Wheelabrator mechanical descaling equipment, now being used to clean pipe skelp edges, serves to underline the versatility this process holds for the steel industry and shows the high degree of control that can be achieved.

In preparing pipe skelp for electrowelding, only a small strip along either edge of the bottom side of the skelp must be cleaned to bare virgin metal to the copper electrodes. Finish on the surface of the pipe, of course, is not critical.

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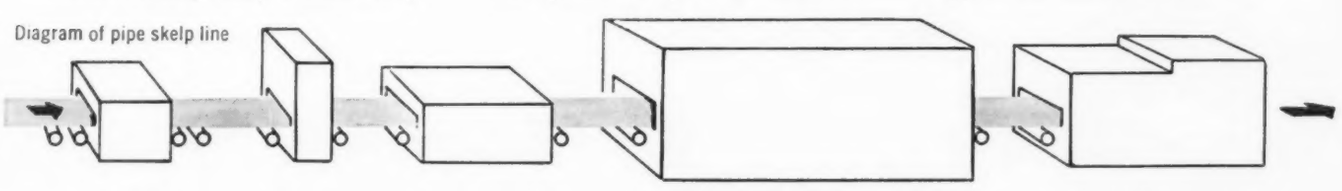
For information on savings you can make with Wheelabrator equipment in all phases of steel descaling, write today for your copy of Bulletin 128-D.

Diagram of pipe skelp line



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DREVER

Plate

Heat Treating Line

Shown
the charging
d of a 145'-0"
rdening furnace.
the background
n be seen a 2500
n pressure quench,
)0'-0" draw furnace
nd the operator's
ontrol pulpit.

This roller-hearth plate heat treating line, known to be the largest of its type, has a capacity to treat plate up to 21-1/2 tons per hour. The equipment is capable of handling plate sizes up to 172″ wide x 3″ thick x 600″ long.

The furnace rolls are 25/12 modified alloy and are designed for a maximum furnace operating temperature of 1650° F.

The maximum fuel capacity for both furnaces is 122,000,000 Btu's per hour.

The entire line is under the control of a single operator. Full utilization of strategically located TV cameras enables the operator to have full control over all operations.

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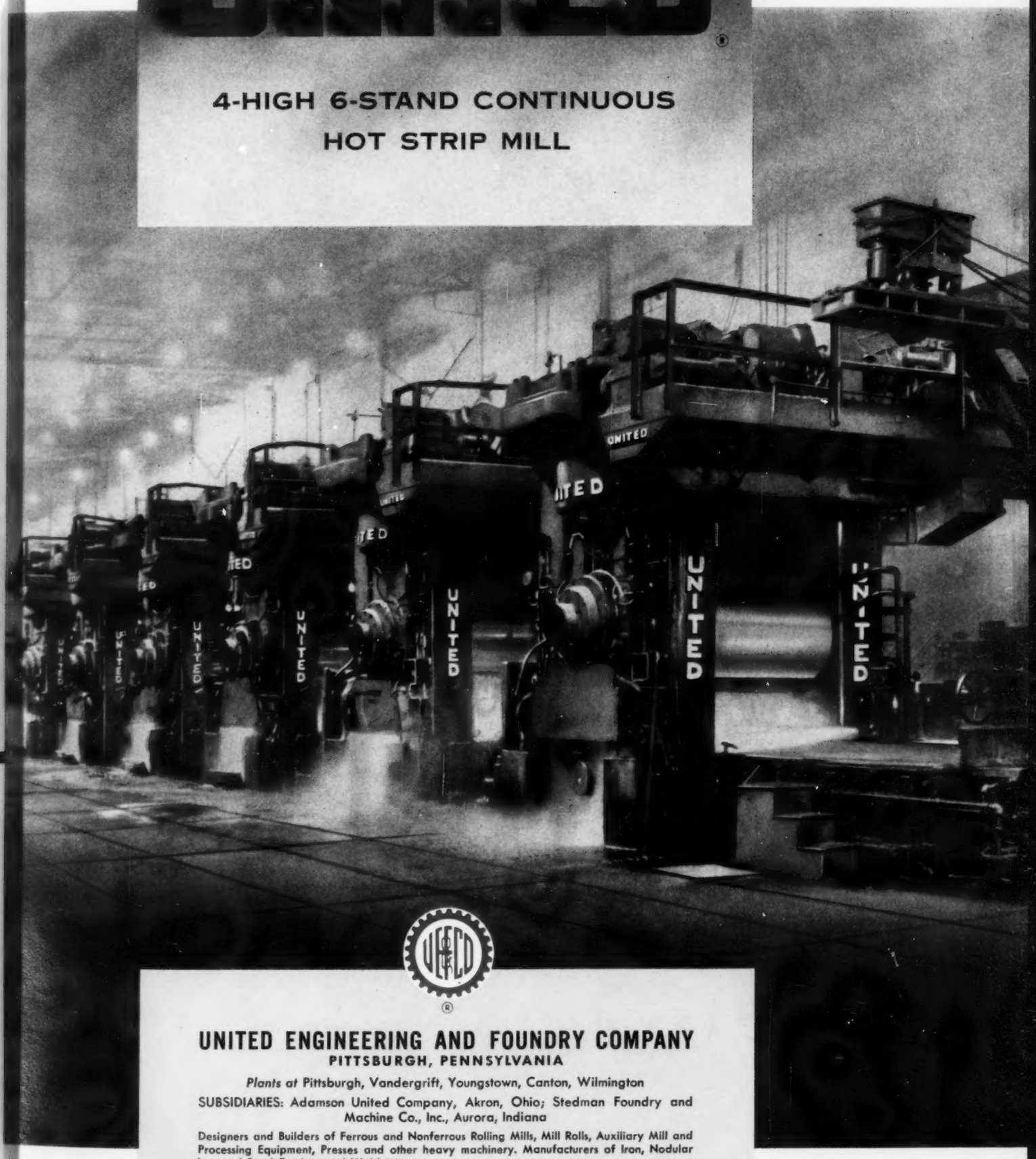
4-HIGH 6-STAND CONTINUOUS HOT STRIP MILL



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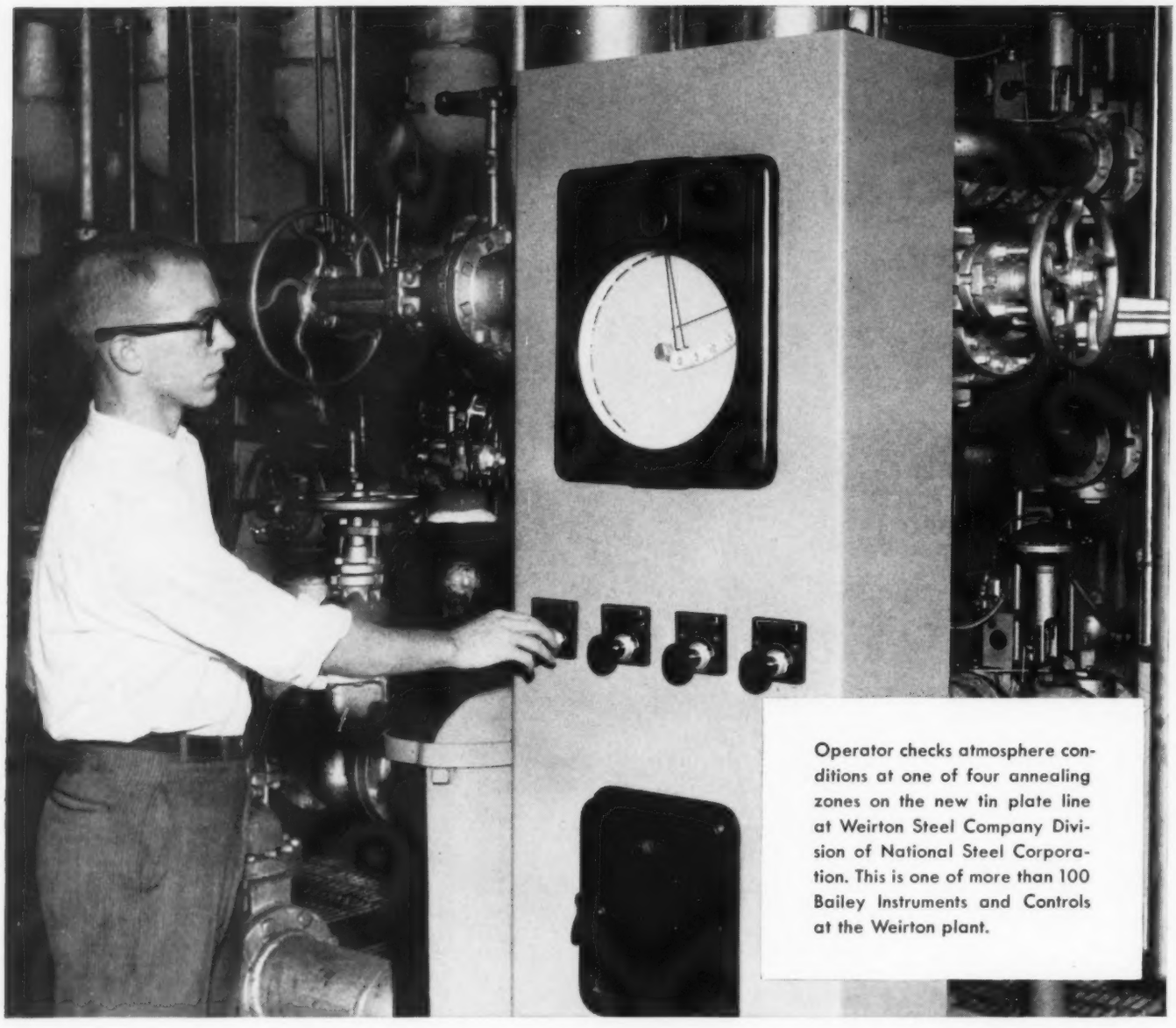

Operator checks atmosphere conditions at one of four annealing zones on the new tin plate line at Weirton Steel Company Division of National Steel Corporation. This is one of more than 100 Bailey Instruments and Controls at the Weirton plant.

This Bailey instrument gives you 2 atmosphere checks for the price of 1

You can measure combustibles *and* oxygen with this Bailey Analyzer-Recorder . . . at less than the price of other instruments that make only single measurements.

Only Bailey gives you a continuous recording of *both* oxygen and combustibles on the same chart for quick, simple comparison. You can reduce costly furnace purging time by accurately measuring oxygen instead of guessing. Measuring oxygen also drastically reduces danger of explosion. The Oxygen Analyzer-Recorder can detect small furnace leakage of steel-scaling oxygen—thus assuring higher product quality.

The Bailey instrument is by far the most efficient and economical way of controlling atmospheric conditions in annealing furnaces. See your Bailey Engineer or write to the Iron and Steel Division for complete information.

SI13-1

IRON AND STEEL DIVISION

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WAGNER Integral-Type Gearmotors

Wagner Integral-Type Gearmotor with TEFC motor. Standard or explosion-proof.

Wagner Integral-Type Gearmotor with open protected motor.

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Wherever you need "slower than motor speeds" you can get positive speed reduction with plenty of power by using Wagner Gearmotors.

This extension to the Wagner line provides compact motorized drives, with both motor and gear housing of corrosion-resistant cast iron. Available with the latest NEMA Frame open protected or totally enclosed fan-cooled motors, they combine Wagner motor dependability with rugged, simplified gear units to give you speed reduction equipment designed for greater capacity and longer life in ordinary up to rough service.

Wagner Gearmotors offer a wide variety of sizes in single, double, triple or quadruple reductions—horizontal or vertical foot or flange mountings—speeds from 7½ to 780 RPM. Write for Bulletin MU-227.

Whether you specify or apply power transmission equipment, your nearby Wagner Sales Engineer will be glad to help you select the right drive for your applications. There are Wagner Branches in 32 principal cities.

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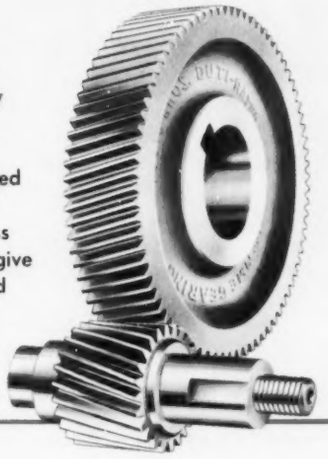
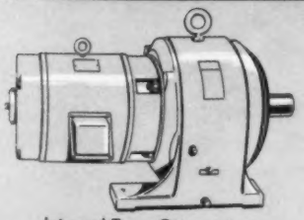


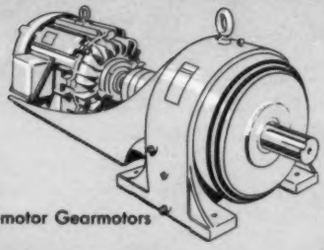
Positive Oil Seals

Improved lip type seals are used on horizontal shafts. On vertical output shafts, double mechanical seal with slinger and drain-off gives positive protection against leakage.

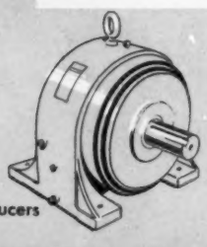
WAGNER SPEED REDUCTION EQUIPMENT



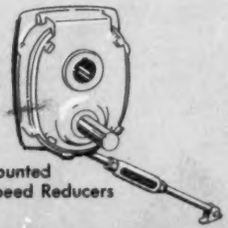
Integral-Type Gearmotors



All-motor Gearmotors

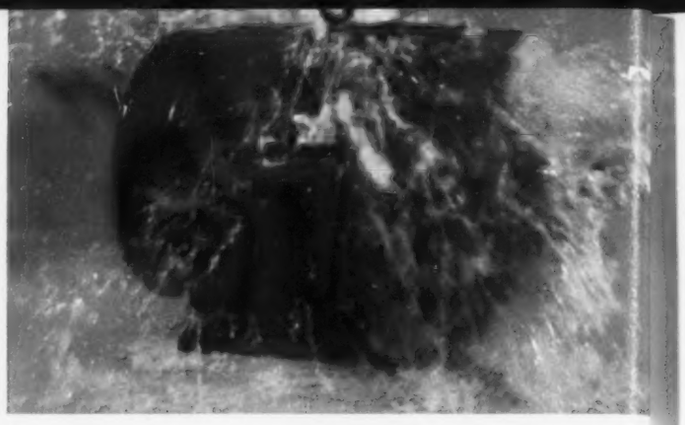


Speed Reducers



Shaft-mounted Speed Reducers

DOUBLY PROTECTED. Air intakes and outlets protect against falling or splashing liquids. Cast iron frames protect against rough handling and corrosion.



TYPE DP · Doubly Protected against corrosion · against falling or splashing liquids

These motors give the double protection of corrosion-resistant cast iron frames and dripproof enclosures that are so well designed that they can be used in many applications that formerly required splashproof motors. Available with ball bearings, or with high load carrying capacity sleeve bearings for extra quiet operation. Write for Bulletin MU-223.

1 TO 125 HORSEPOWER – 1750 RPM – 40° C – NEMA FRAMES 182 THROUGH 445U

You get less downtime, lower upkeep, with WAGNER PROTECTED-TYPE MOTORS

If you need motors that will keep production rates up . . . that will give you the continuity of service you want . . . that will operate with complete dependability under the most severe conditions in their specific applications—use Wagner Protected-Type Motors. These motors pack extra power into little space, are light in weight, and are easy to maintain.

Let your Wagner Sales Engineer show you how these protected motors can bring you savings in initial motor costs, maintenance costs, and in continuity of operation.

Wagner Electric Corporation
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WM59-10

1 TO 100 HORSEPOWER – 4 POLE – 60 CYCLE – NEMA FRAMES 182 THROUGH 445U

TYPE EP · Extra Protected against corrosive or abrasive elements

Wagner Type EP Motors are totally-enclosed, fan-cooled—for complete protection against dust, abrasives, fumes, steel chips or filings. Type JP is explosion proof as well—designed and approved for use in explosive atmospheres. Cast iron frames protect against corrosion and ribs on the frames add mechanical strength and increase the surface cooling area. Effective cooling system adds to motor life. Write for Bulletin MU-224.

SECURELY SEALED FOR LOW MAINTENANCE. Both ends of these motors have running shaft seals to keep the heavy duty bearings clean. Bearing housings are effectively sealed to prevent escape of grease. Openings are provided to permit relubrication that adds years to motor life under severe conditions.

Rapid-travel planer at Freitag's Plant.

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When Salem-Brosius' subsidiary, the Alloy Mfg. Corp., acquired R. H. Freitag Mfg. Co., Salem-Brosius became an integrated supplier of parts and components for the nuclear energy program. This additional 110,000 sq. ft. of precision machining capacity joins with Alloy's AEC and U.S. Navy approved fabricating capacity, permitting complete production control of nuclear contracts.

Freitag's product list is diversified, including plastic molding, rubber molding, stamping and die casting dies; jigs, fixtures, tools, gages and production—as well as precision—machining of components for industrial, commercial and consumer products of all kinds. This manufacturing capacity complements the complete engineering and erection service offered by Salem-Brosius on furnaces, plants, production lines and processing plants for steel, non-ferrous metals, glass and many other production industries.

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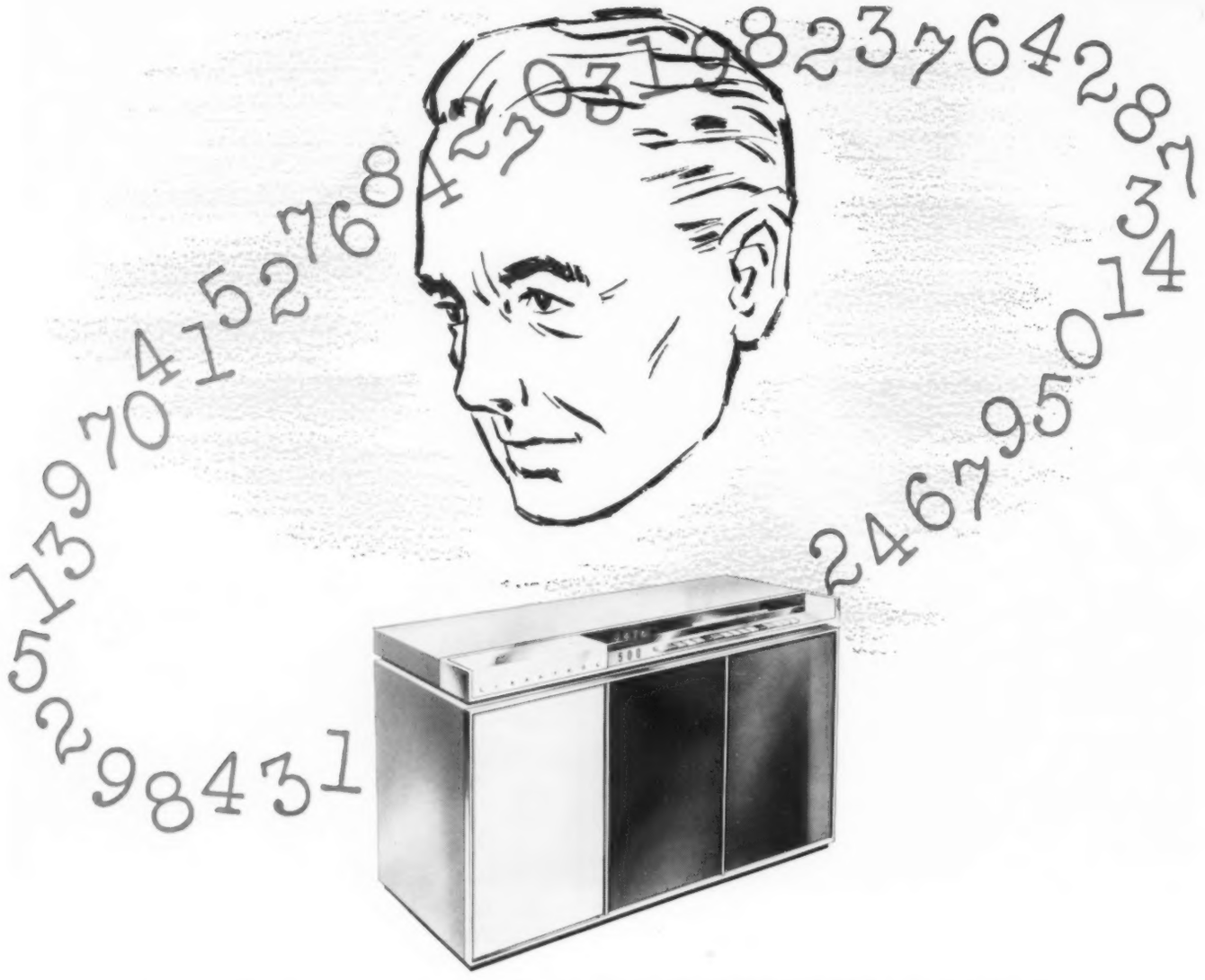

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GPE Controls, Inc. (formerly Askania Regulator Company)
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GPE Controls | A GENERAL PRECISION COMPANY

A Subsidiary of GENERAL PRECISION EQUIPMENT CORPORATION

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be oblained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period December 2, 1958 through December 23, 1958.

CONTINUOUS IRON AND STEELMAKING IN A ROTARY VESSEL

△ U. S. 2,862,811, issued Dec. 2, 1958, to Sven G. H. Eketorp and Sven H. Backstrom, assigned to Stora Kopparbergs Bergslags Aktiebolag, describes a process and apparatus for the continuous refining of iron in a rotary vessel.

In Figure 1, the container 1 is rotated by a driving belt 2. Pig iron is charged, together with a flux and a cooling material, such as scrap iron of fine-grained ore, at the top of the container through a pipe 3, and oxygen is introduced through a pipe 4 in the center of the container. The combustion gases leave the vessel through opening 5. The slag 7 produced will form a layer inside the iron bath 8 and will not come into contact with the wall 9 lined with ceramic material. The formation of fumes which is usually very annoying when refining with pure oxygen, is easily mastered, as the oxygen, according to this invention, can be brought into contact with the bath surface much more uniformly than with methods in use up till now. As the kiln is charged, the thickness of the layer of material 7, 8 is increased, and molten material leaves the kiln through the tapping hole 10. In comparison with the quantity of iron charged in the kiln, the surface of the bath is very large, which makes it possible to carry out the refining very rapidly. On account of its higher specific gravity, the low carbon steel, produced during the process will form a layer close to the wall, whereas the pig iron, which should be exposed to the oxygen, gathers inside the steel layer. This type of kiln enables continuous operation, and the kiln itself need not be large, as the iron can pass through it relatively quickly.

According to the inventor, the vessel can also be used for pig iron production, in which case it is charged with concentrates or fine-crushed ore and coke or coal breeze, and oxygen is introduced as described above in the center of the kiln. The carbon added is dissolved in the pig iron, and the reduction of the ore takes place in the pig iron melt with the carbon dissolved in the pig iron. The heat required is created by combustion with pure oxygen of the carbon monoxide formed during the reduction and of the extra amount of coke that might be necessary. The pig iron produced is tapped through the central hole in the bottom.

If two fluid phases having dif-

Figure 1

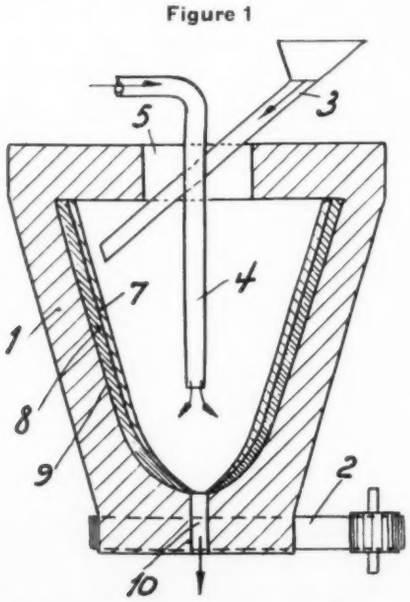


Figure 2

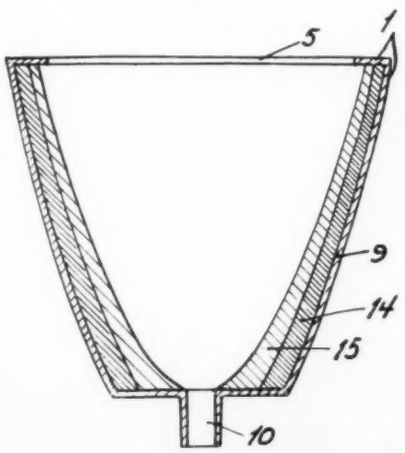
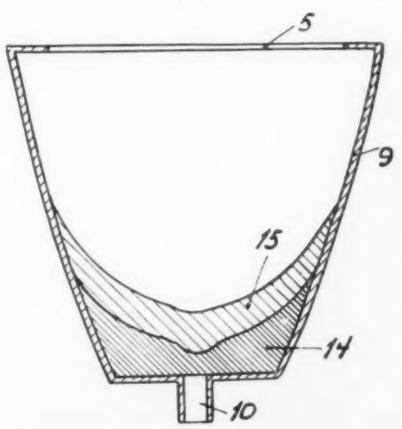


Figure 3



ferent specific gravities are present in the reaction vessel, it is possible, by variation of the speed of rotation, to tap out one or the other phase just as desired. When the inside diameter of the lighter phase 15 coincides with the diameter of the bottom hole 10 as illustrated in Figure 2, a small decrease in the speed of rotation will cause this phase to run out through the hole. On the other hand it is possible to make the heavy phase 14 spread out over the whole bottom under the lighter one 15 by lowering the speed of rotation, and it is then possible to tap out only the heavier liquid, as is shown in Figure 3. By adjusting the speed of rotation properly, it is possible to control every tapping from the vessel, and in that way to determine the time of treatment as desired.

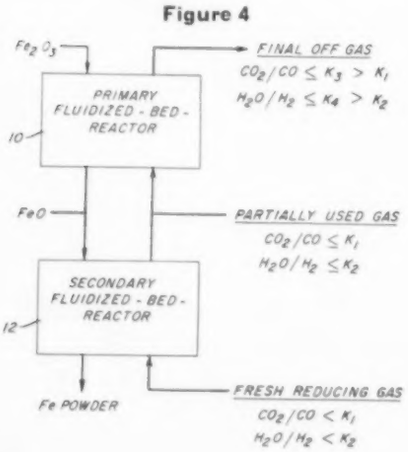
TWO-STEP METHOD OF REMOVING OXYGEN FROM IRON OXIDE

△ U. S. 2,864,688, issued Dec. 16, 1958, to Thomas F. Reed, assigned to United States Steel Corp., describes a two-step method of removing oxygen from iron oxide, in fluidized-bed reactors.

As shown in Figure 4, FeO is produced in the first stage, and iron powder in the second. The reducing gas from the second stage is re-used in the first stage, thereby having a decreased content of reducing constituents in the first stage.

In Figure 5 curves K_1 and K_2 represent the maximum ratios CO_2/CO and H_2O/H_2, respectively, which the reducing gas can contain and yet have capacity to remove oxygen from FeO and reduce it to metallic iron. Similarly curves K_3 and K_4 represent the maximum ratios for removing oxygen from higher oxides and reducing them to FeO. Therefore to maintain maximum efficiency of gas consumption per pass it is necessary to maintain CO_2 and H_2O in the fresh incoming gas at a minimum so that the ratios CO_2/CO and H_2O/H are well below K_1 and K_2. It is also necessary to maintain process conditions in the secondary reactor such that the reactants are in contact long enough to approach equilibrium conditions, and in the off-gas the ratios are as close as possible to K_1 and K_2.

Figure 4



A modification of the process is described by Jagdish C. Agarwal in U. S. 2,864,686 (same date and same assignee).

METHOD OF ASSEMBLING A SEAL FOR A BLAST FURNACE DISTRIBUTOR

△ U. S. 2,864,158, issued Dec. 16, 1958, to Percy J. Hake, assigned to United States Steel Corp., describes a method of assembling a seal for a blast furnace top.

The patent provides a method of assembling a seal construction for blast-furnace distributors, whereby the seal rings are positively secured to the distributor yet can be inserted in grooves in a unitary base ring, thus avoiding practically all maintenance and ensuring that the seal will serve effectively for the full length of a normal furnace campaign.

The method employs unitary sealing rings each having an overlapping joint at one point on its circumference whereby the ring

Figure 5

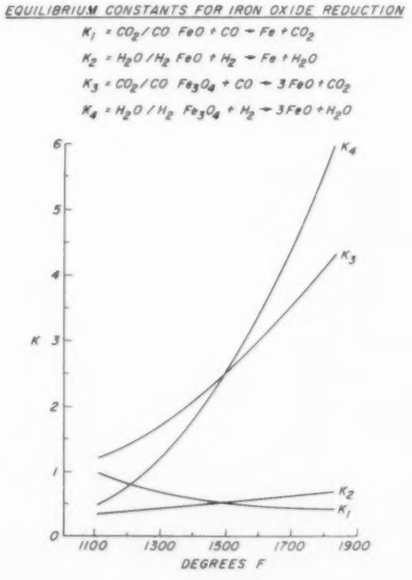

EQUILIBRIUM CONSTANTS FOR IRON OXIDE REDUCTION
$K_1 = CO_2/CO$ $FeO + CO \rightarrow Fe + CO_2$
$K_2 = H_2O/H_2$ $FeO + H_2 \rightarrow Fe + H_2O$
$K_3 = CO_2/CO$ $Fe_3O_4 + CO \rightarrow 3FeO + CO_2$
$K_4 = H_2O/H_2$ $Fe_3O_4 + H_2 \rightarrow 3FeO + H_2O$
K
DEGREES F
1100
1300
1500
1700
1900

Figure 6

Figure 7

may be contracted sufficiently to be inserted in its slot in the base ring and then permitted to expand to normal size for receiving the distributor. Alined radial holes are drilled in the seal rings and base ring and the distributor is then assembled with the base ring and marked for the drilling of radial holes therein alined with those in the seal rings and base ring. The distributor is then removed from the base ring and drilled, and the holes in the seal rings are tapped. On reassembling the base ring and distributor, the seal rings are fastened to the distributor by screws, and thus positively secured.

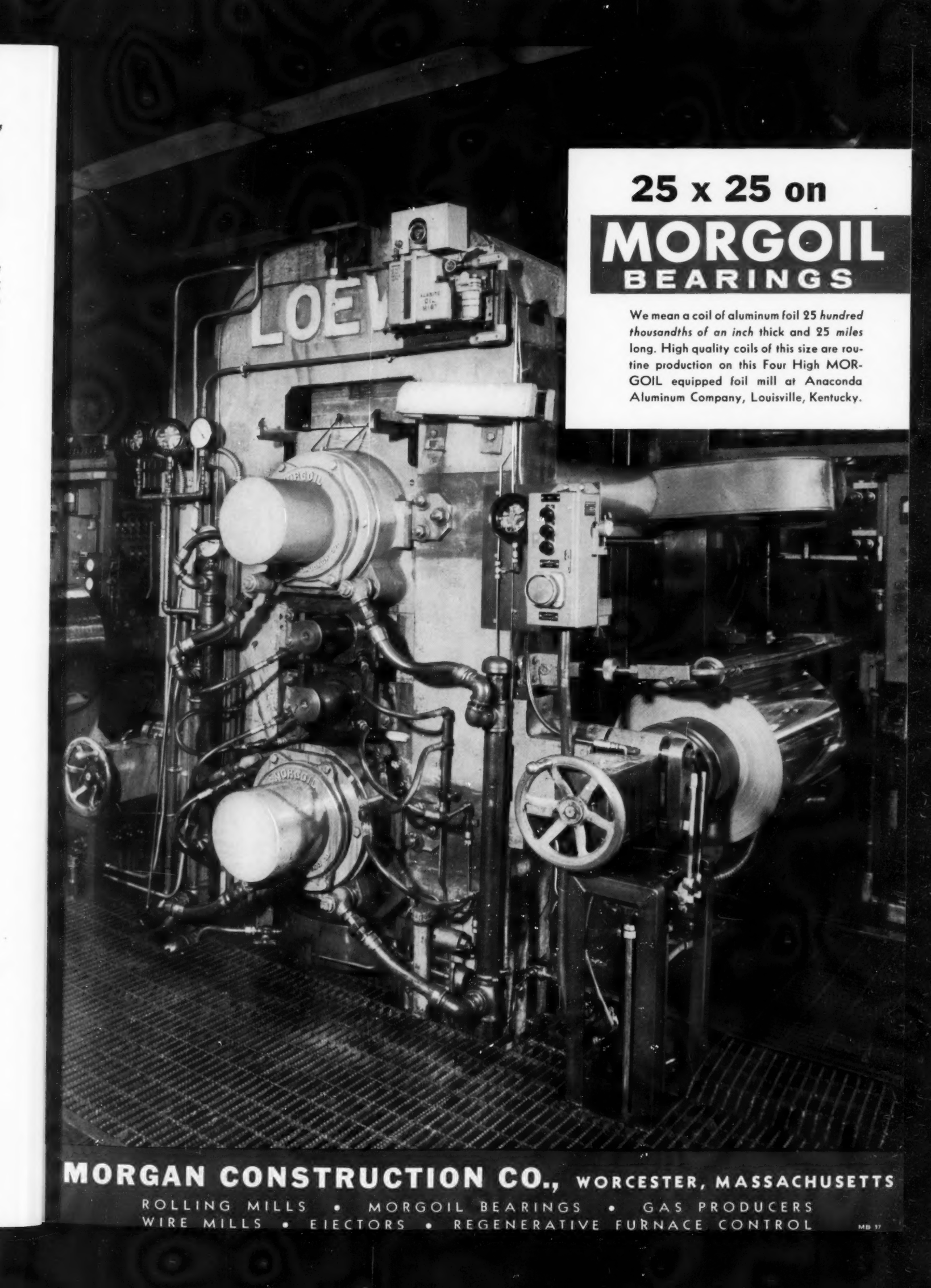
Figure 6 shows the base ring, and Figure 7 seal ring.

DIRECT PRODUCTION OF STEEL FROM IRON ORES

△ U. S. 2,865,734, issued Dec. 23, 1958, to Sidney Klemantaski, assigned to the British Iron & Steel Research Association, provides a process for the direct production of steel from iron ores in a single continuous process.

In Figure 8, ore and coal are fed into tubes 112b where they descend, the ore being progressively reduced by the partial combustion of the coal, the required heat being transferred through the walls of the tubes 112b and 112a. The desired temperature is maintained in the column 113b, 113a by the supply of air through the ducts 120 to control combustion of the gases.

From the tubes 112, the partially reduced ore passes with the coal into the combustion chamber 114 where flux is added if required and air is introduced through nozzle 115. The oxygen of the air reacts exothermally with the descending material and to supply a source of heat to agglomerate the metal. When the ores reach the chamber 114, they have already been reduced to carburized iron, and the amount of oxygen supplied through nozzle



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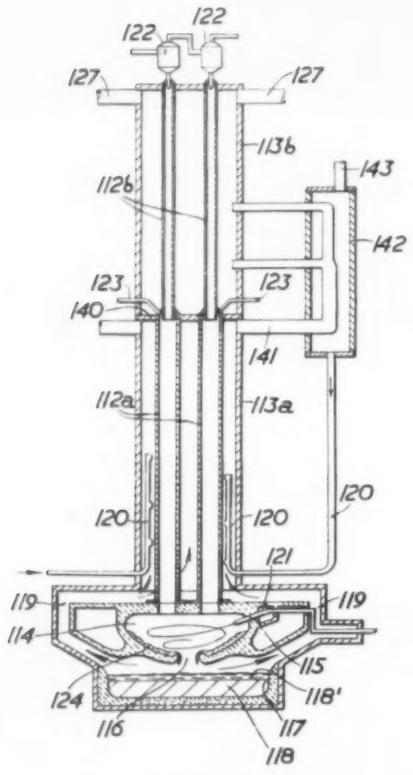

Figure 8

115 is adjusted so that the oxygen potential of the metal is raised to that of the steel required.

The nozzle 115 and the chamber 114 are arranged to cause a cyclone action in chamber 114 to increase the time of reaction in the chamber and to cause slag and metal to be thrown on to the walls of the chamber. The metal as it passes over the slag covered walls is subject to the reaction so that when it passes out of the chamber into the hearth 117 it has been brought substantially to the desired oxygen potential.

The hot gases leave the chamber 114 by the opening 116 and pass over the hearth. Here they pass over the agglomerated liquid to provide heat and chemical potenial for any incompleted reactions and to make good heat losses.

The hot gases leaving the hearth through the pipes are reduced in temperature to that desired for the recuperator column 113. They may thus be used to generate high pressure steam and to preheat the air fed to nozzle 115. A fraction of the gases is also burnt in a chamber 121 to raise the temperature of the air to the temperature of melting iron; without this preheating, it is necessary to supply oxygen to nozzle 115 or to charge additional fuel to avoid the reaction being cooled by large volumes of inert cold nitrogen.

APPARATUS FOR DIP SAMPLING MOLTEN METALS

△ U. S. 2,865,204, issued Dec. 23, 1958, to Benjamin S. Lamb, assigned to United States Steel Corp., describes apparatus for separating a solidified sample from a dip sampler body which has been immersed in a metal bath to obtain the sample. The object is to obtain samples in the form of pins suitable for spectrographic analysis, as well as a thin-walled, frangible shell suitable for chemical analyses.

The apparatus is shown in Figure 9. When it is desired to obtain a sample of a molten metal the device, by means of ring 22′, is suspended from a rod or hook which is then manipulated to dip the lower portion of body 4′ into the molten metal. For best results the body 4′ should not be submerged beyond a point approximately midway of its length.

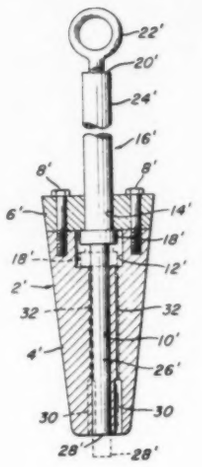

Figure 9

When the body has been properly submerged. the shell formed around it may be readily removed by merely shaking the dip sampler. Deeper submersion causes formation of a more tightly clinging shell which then requires the use of the ram 16′ for removal. Duration of immersion determines the wall thickness of the solidified shell that will be formed.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,862,469	12/2/58	Production of tubing from strip metal.	Spiro Establishment
2,862,807	12/2/58	Updraft pelletizing method.....	The Cleveland-Cliffs Iron Co.
2,862,808	12/2/58	Reduction of iron oxide pellets.....	Fredrik W. de John
2,862,810	12/2/58	Apparatus for reducing the silicon content and increasing the temperature of molten pig iron.....	Georges Alexandrovsky
2,862,812	12/2/58	Corrosion-resistant steels.....	Crucible Steel Co. of America
2,862,841-2	12/2/58	Pretreatment of iron or steel base for single coat vitreous enameling....	Inland Steel Co.
2,863,189	12/9/58	Ladle nozzle construction.....	Harold S. Beck
2,863,192	12/9/58	Hot top mold assembly.....	Valley Mould & Iron Corp.
2,863,643	12/9/58	Galvanizing furnace temperature control.....	Oscar R. Olson
2,863,755	12/9/58	Oil-treated calcium carbide for desulphurization of iron.....	Union Carbide Corp.
2,863,756	12/9/58	Production of high-grade Thomas steel.....	Huettenwerk Haspe A. G.
2,863,763	12/9/58	Ductile and tough high-strength steel	Secretary of the Navy
2,863,764	12/9/58	Coated magnesium iron treatment...	Air Reduction Co., Inc.
2,863,792	12/9/58	Removal of scale from alloy steel....	Superweld Corp.
2,863,807	12/9/58	Coke oven structure.....	Koppers Co., Inc.
2,864,171	12/16/58	Open hearth furnace.....	Maerz Industrie-Ofenbau A. G.
2,864,607	12/16/58	Apparatus for making high-tensile steel strapping.....	Sharon Steel Corp.
2,864,687	12/16/58	Pelletizing method.....	United States Steel Corp.
2,864,689	12/16/58	Desulphurizing and desiliconizing a bath of pig iron.....	Societe d'Electro-Chimie d'Electro-Metallurgie et des Acieries Electriques d'Ugine
2,865,520	12/23/58	Charging apparatus for horizontal coke ovens.....	Koppers Co., Inc.
2,865,575	12/23/58	Strip coiling mandrel.....	United States Steel Corp.
2,865,731	12/23/58	Iron ore briquette with paper pulp binder.....	Minerals & Chemicals Corp. of America
2,865,732	12/23/58	Production of sponge iron.....	Norsk Hydro-Elektrisk Kvaelstofaktieselskab
2,865,735	12/23/58	Reduction of the sulphur content in iron.....	Knorr-Bremse G.m.b.H.
2,865,740	12/23/58	Precipitation-hardening nonmagnetic ferrous alloys	United States Steel Corp.
2,865,741	12/23/58	Acid-resistant austenitic stainless steel.....	United States Steel Corp.

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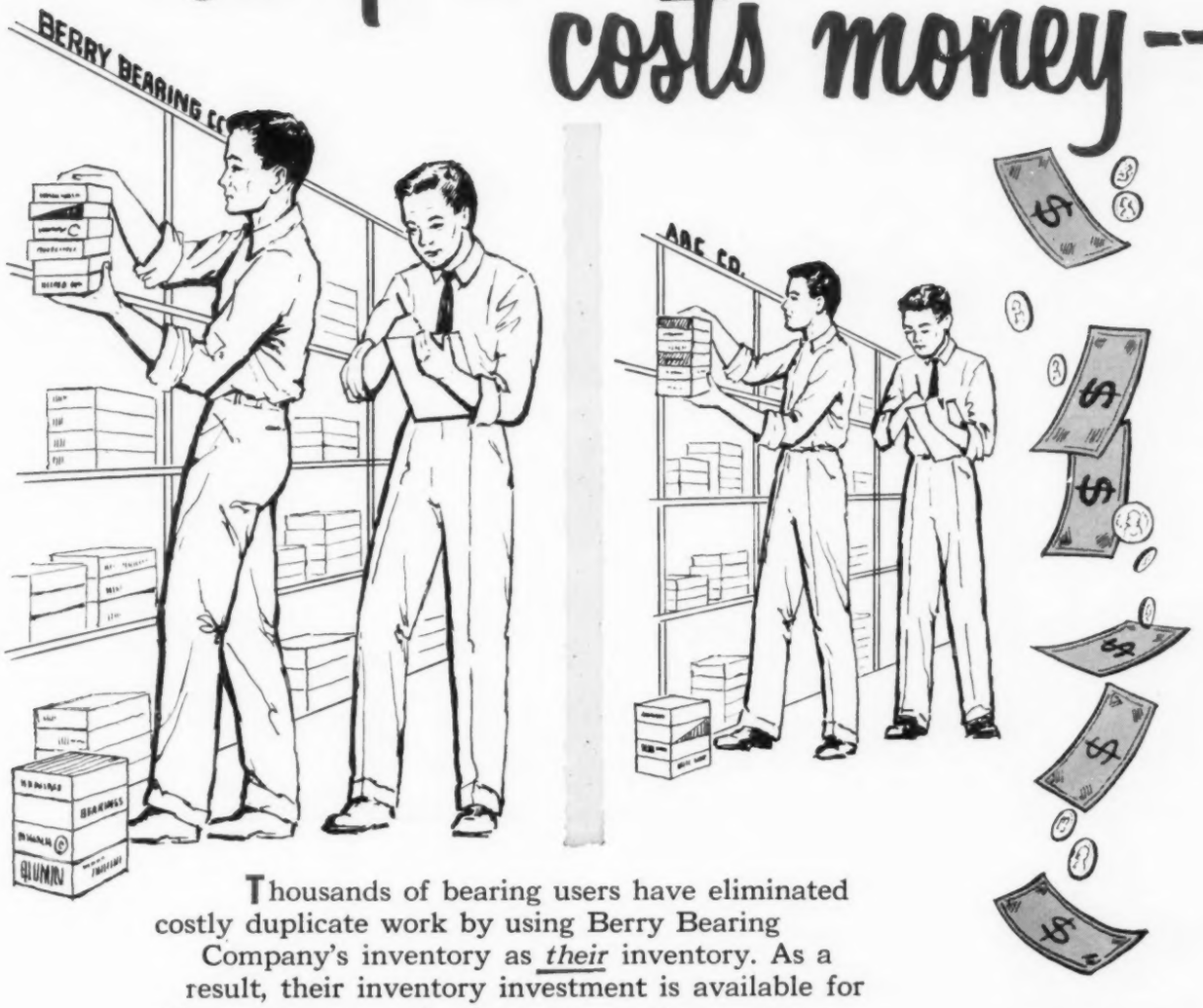

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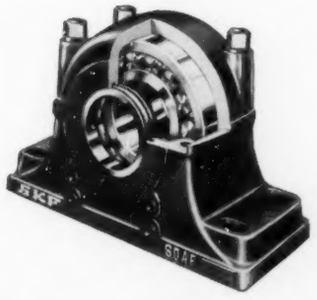

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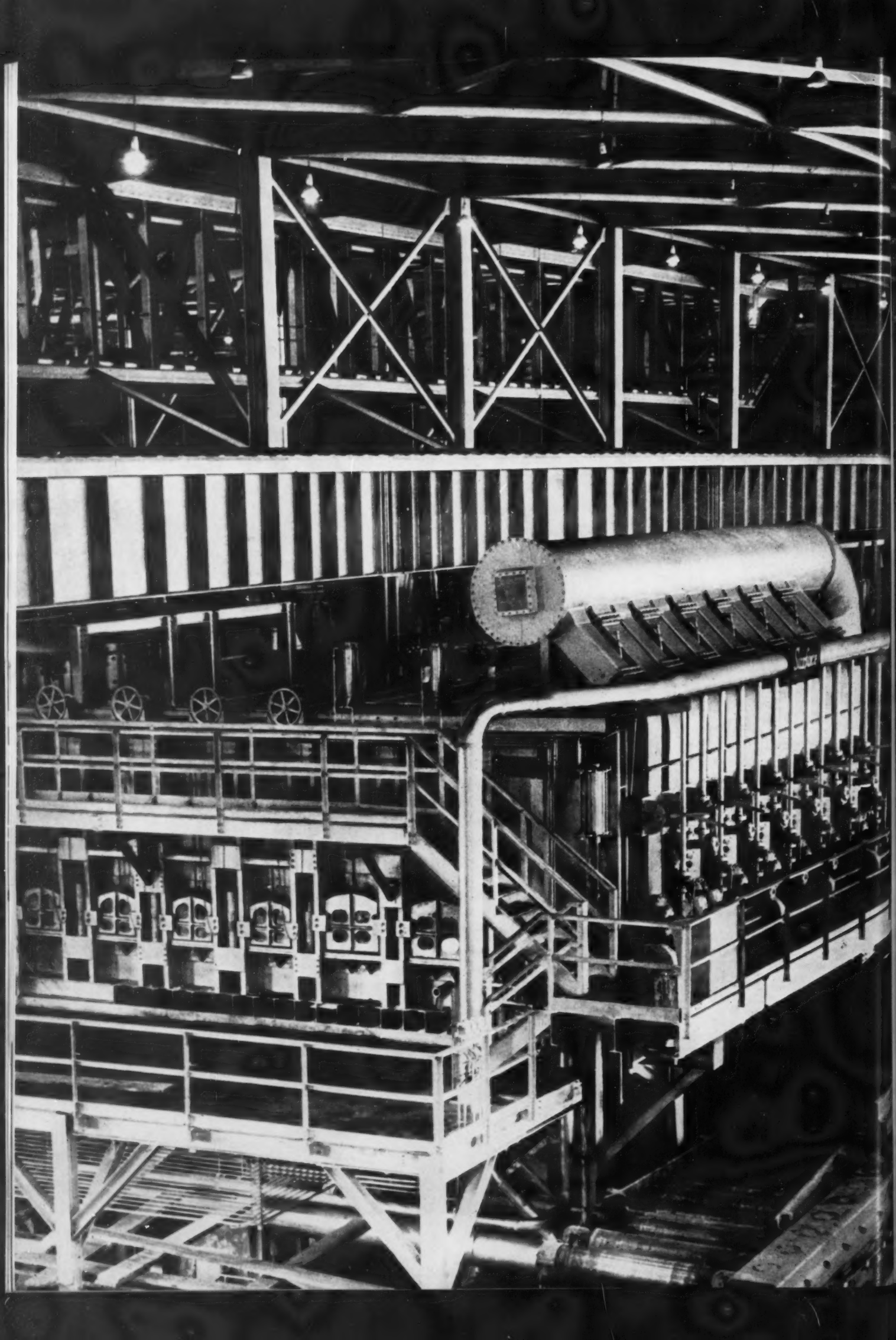

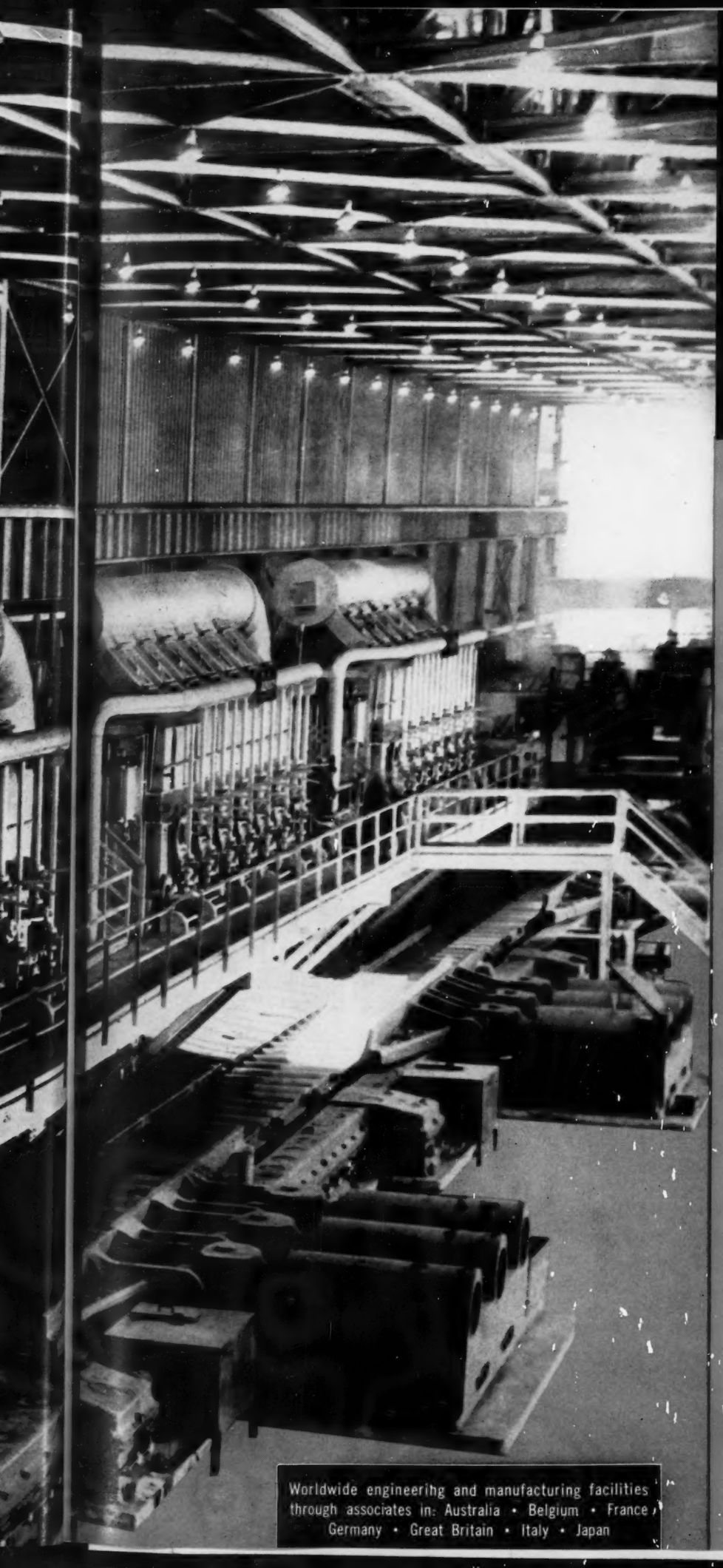

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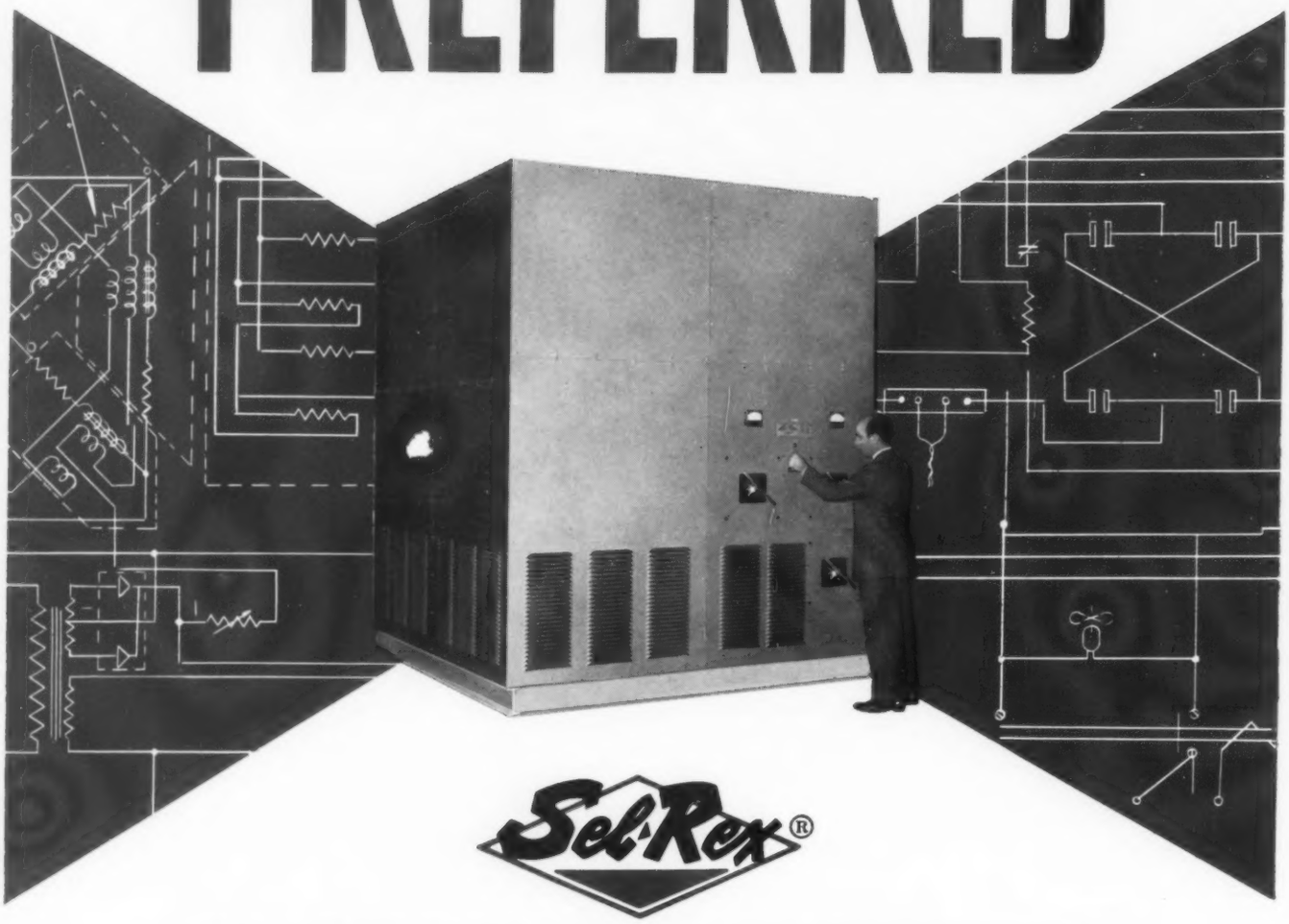

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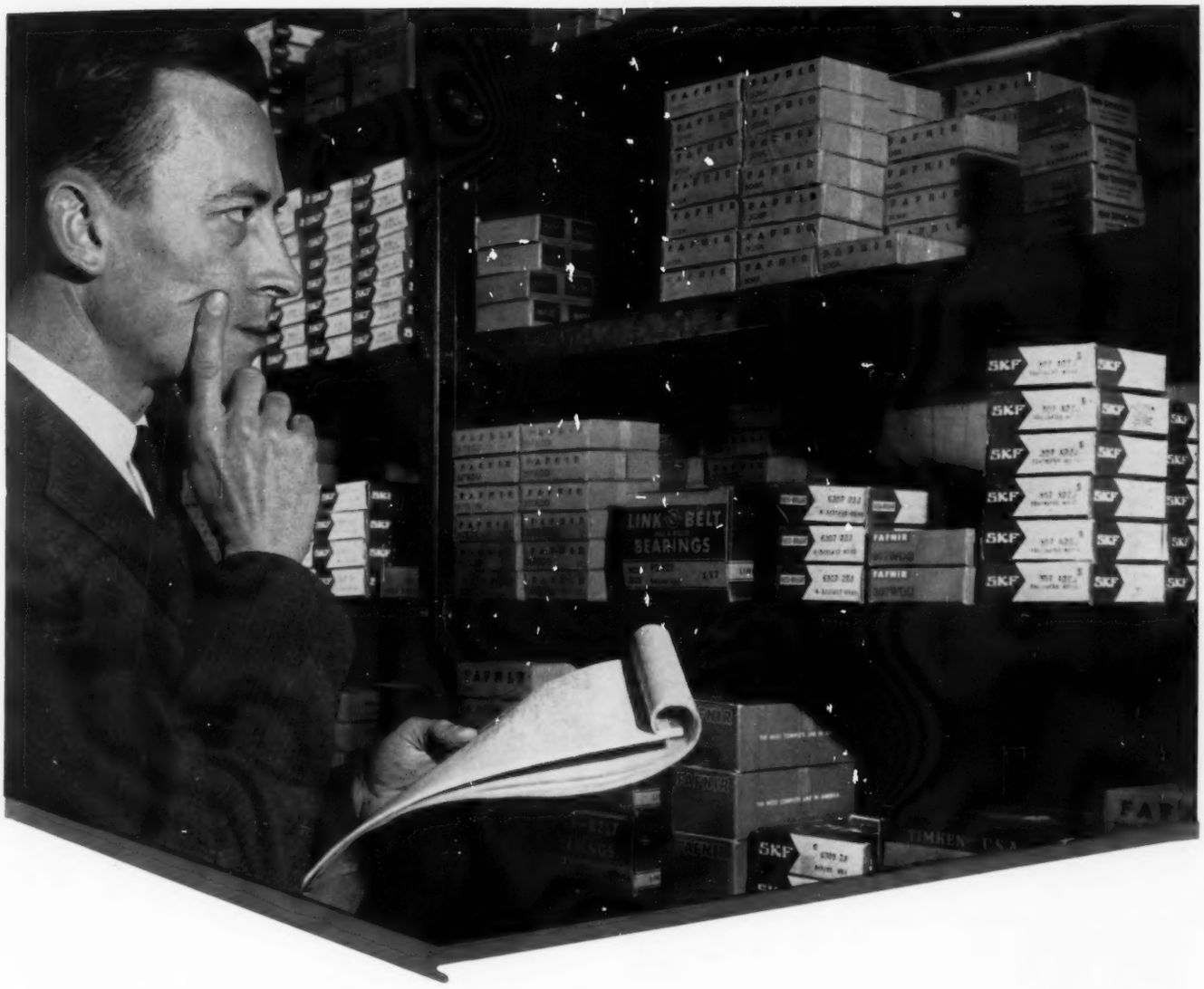

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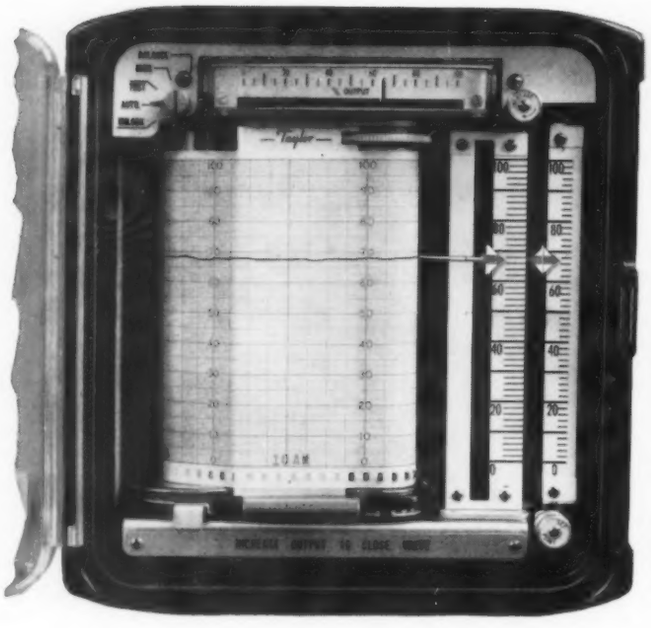

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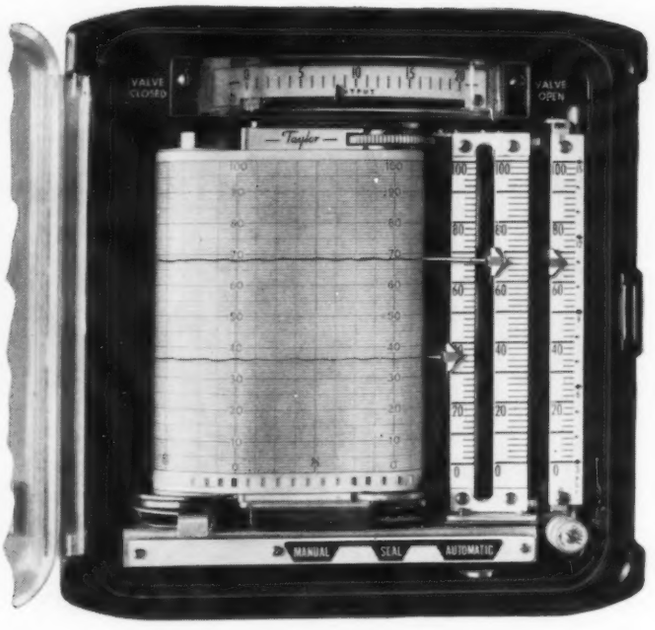

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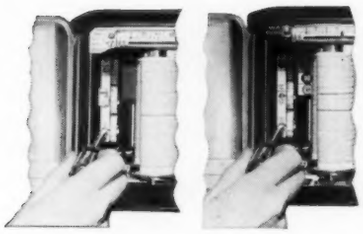

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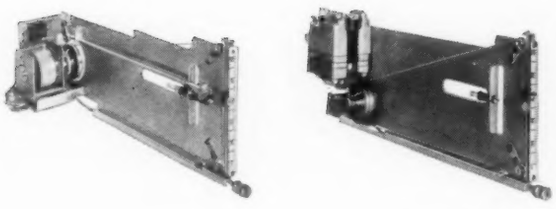

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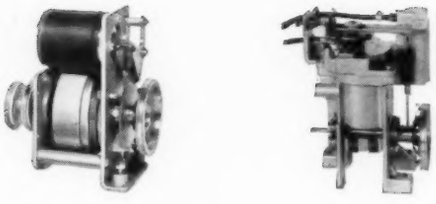

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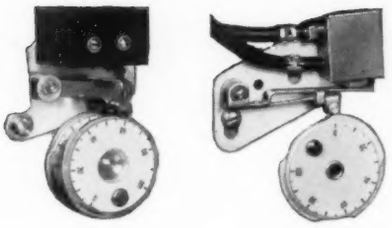

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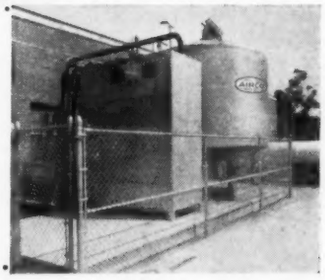

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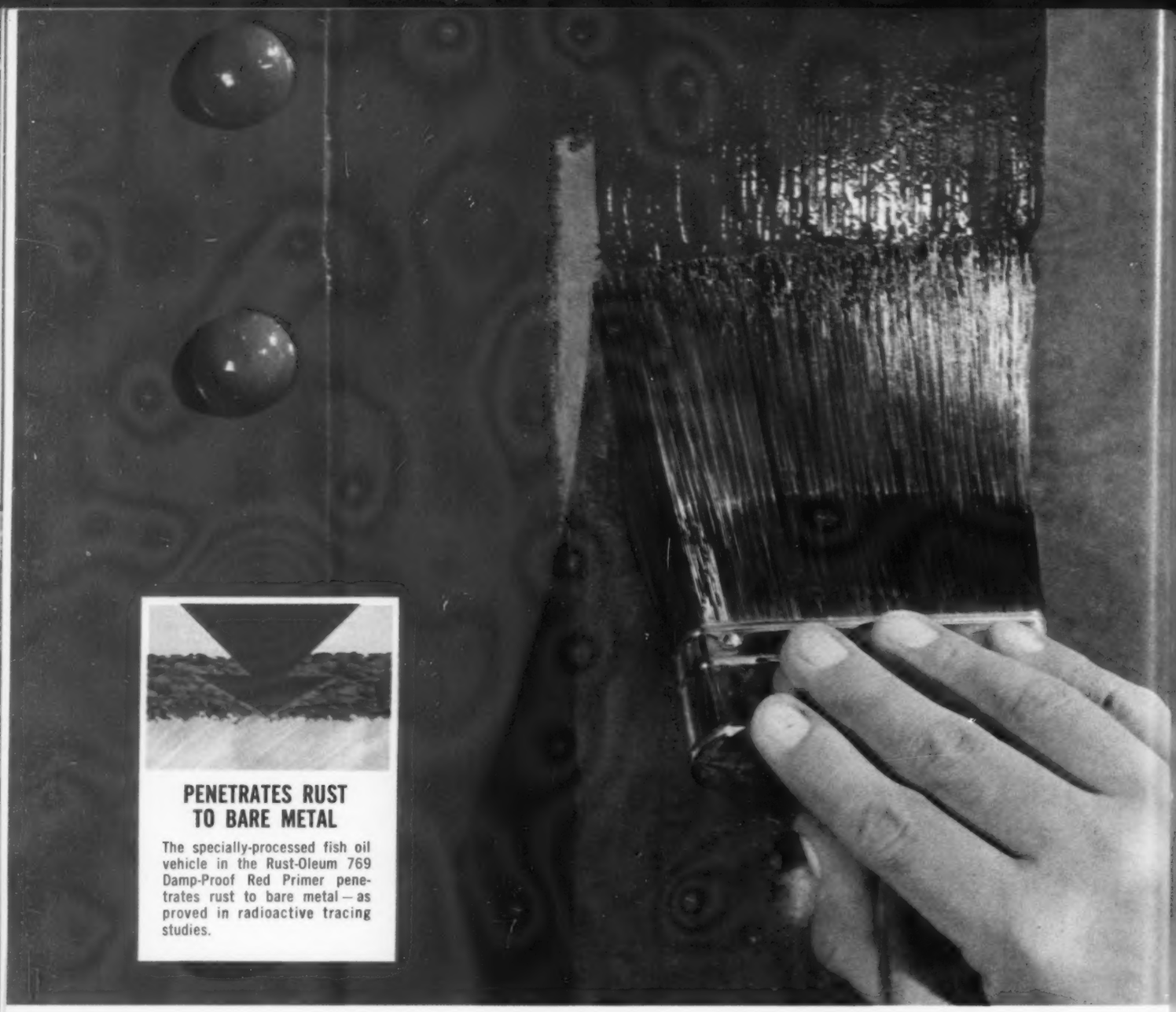

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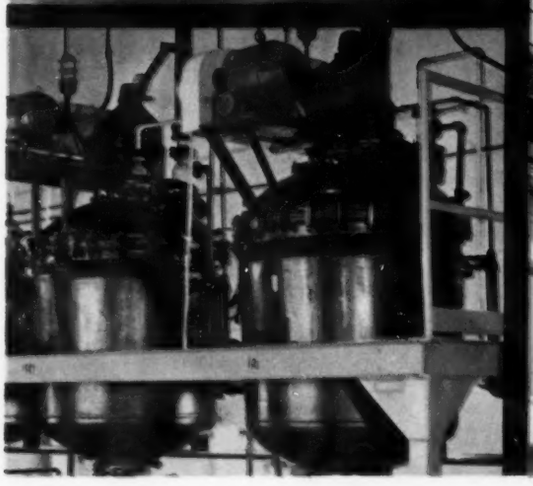

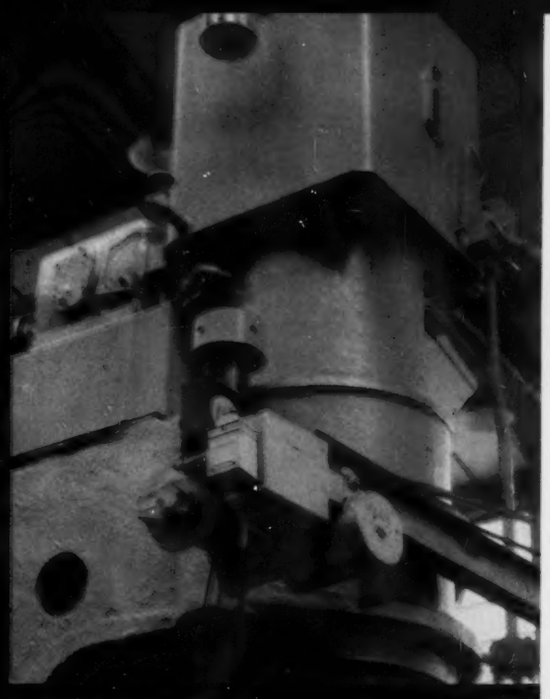

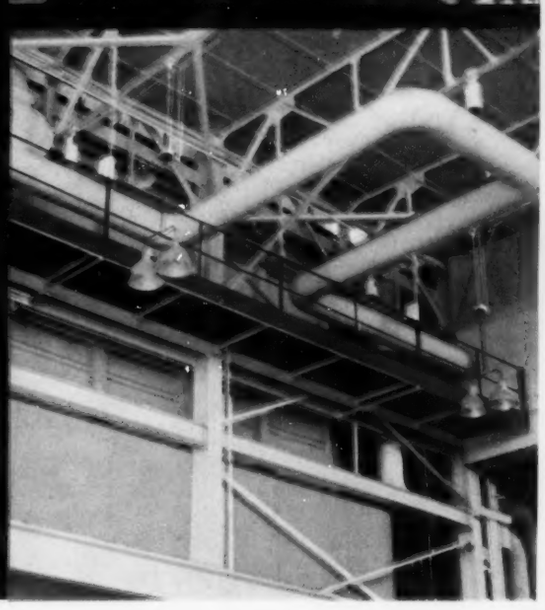

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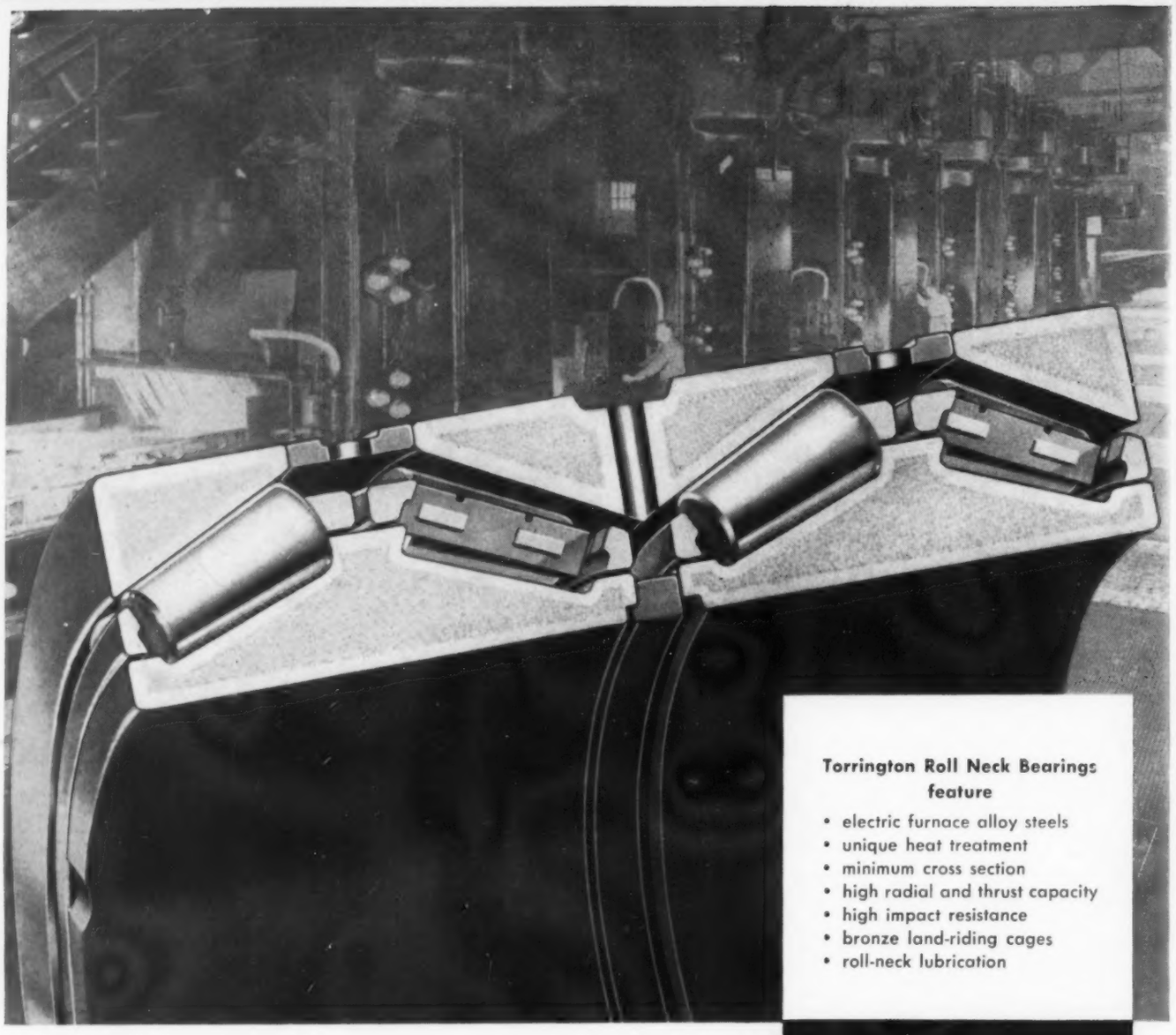


Torrington Roll Neck Bearings feature

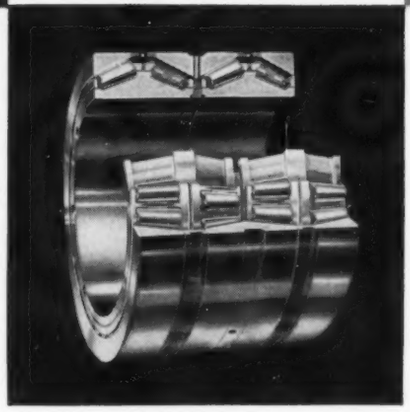
- electric furnace alloy steels
- unique heat treatment
- minimum cross section
- high radial and thrust capacity
- high impact resistance
- bronze land-riding cages
- roll-neck lubrication

Torrington Roll Neck Bearings stand out in performance

Where tonnage rolled and down time saved are the measure of performance, Torrington Roll Neck Bearings stand out.

For toughness, surface hardness and uniformity, only the highest quality electric furnace alloy steels are used. Advanced heat-treating technique produces maximum impact resistance and optimum wear quality. These refinements permit use of larger diameter rollers and steeper angles with no increase in bearing boundary dimensions. To minimize roll-neck galling under creep conditions, lubricant grooves are provided on cone faces.

Over a quarter century's experience in supplying the finest bearings to the steel industry makes Torrington quality a byword in the industry. Torrington Roll Neck Bearings measure up to your most exacting requirements for rolling mill applications. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**



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This is a Dowell Service Engineer. He is an expert in the use of chemical solvents to remove scale and sludge from your process systems, boilers, tanks and piping.

Using the exclusive Dowell methods of chemical cleaning, this engineer can free up the profits that these deposits cut from your operating ledger.

More than 15 years experience in all industries—for example, oil refining, chemical, steel, public utilities and paper—give Dowell engineers full knowledge of the problems of cleaning plant equipment.

Add to this experience the benefits you get in special equipment, chemicals, research and trained people.

Put this ability and experience to work for you. Let the Dowell man engineer a profitable chemical cleaning program for you. Dowell—the largest, the oldest, the most experienced chemical cleaning service—Tulsa 1, Oklahoma; and 165 stations and offices in major industrial centers.

Chemical cleaning service for all industry

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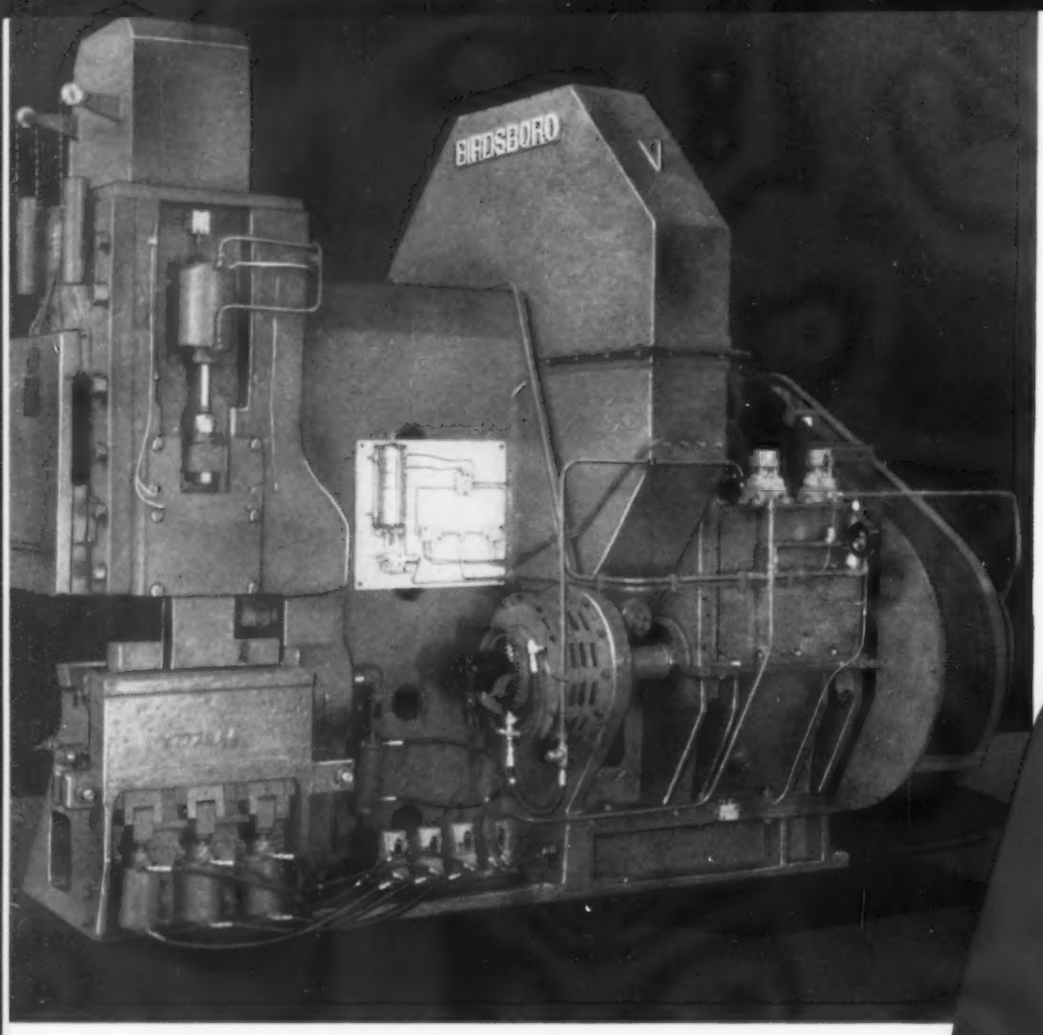
DIVISION OF THE DOW CHEMICAL COMPANY



500-ton Birdsboro Down-cut Shear with Wichita Clutch and Brake

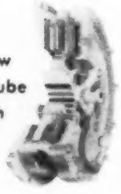
"Wichita Clutches IMPROVE DESIGN and performance"

says
E. C. Peterson, Vice President
Rolling Mill Equipment Division
BIRDSBORO STEEL FOUNDRY
AND MACHINE COMPANY

"Wichita Clutches have been used five or six years on many of our clutch applications," says Mr. Peterson, "and we have experienced definite advantages over clutches formerly used. This has been an important factor in improving the design and performance of Birdsboro Shears."

Tough clutching and braking applications on many types of machines have demonstrated again and again the outstanding advantages of Wichita performance. Be sure you are getting the best equipment there is . . . check with the Wichita Clutch and Brake Specialist nearest you .

Wichita Low Inertia Air-Set Disc Brake



Wichita Low Inertia Air-Tube Disc Clutch

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

Contact your nearest Wichita Engineer!

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Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"ELECTROCHEMICO-MECHANICAL MACHINING OF HARD METALS"

by B. S. KORSHUNOV. (Translation No. 4441 from Vestnik Mashinostroeniya, vol. 37, 1959, No. 9)

Δ WHEN articles of hard metals being machined are immersed in an electrolyte, microcouples are formed between cementing agent (cobalt) and electrolyte. Since an aqueous solution of copper sulphate is usually employed, there is interaction with copper and cobalt goes into solution, while copper deposits on the surface of the part being machined, thus forming a protective film. The surface layer of the specimens becomes softer.

Machining occurs by the mechanical action of abrasive particles on the surface being worked; the copper film and the "loosened" surface layer of hard metal are easily removed, and destruction of the binder starts anew. A number of variables involving chemical, electrical and mechanical factors affect this process.

In 1956 this method of machining was studied at the Research Institute for Agricultural Machinery and as a result some recommendations can be made.

The machining rate increases as the voltage increases, but the finish changes at the same time, and so does the dimensional accuracy. Voltage should not exceed 6 to 8. As rotation speed and feed increase, the machining rate increases, the feed having a greater influence than the speed.

Speed of the cathode should not exceed 4 to 5 fps. Otherwise the working liquid spatters, and at feeds above 49 fpm, considerable build-ups appear at the edges of the carbide tips.

Electrochemico-mechanical machining is three to four times as fast as chemico-mechanical treatment.

The use of alternating-current does not raise machining rate and does not improve machining quality. Electrochemico-mechanical machining on direct-current can be speeded up not only by change of the electrical conditions, but also of the temperature, since the electrolyte heats up to 95 to 105 F during working.

It can be concluded that to increase machining rates low-voltage direct-current (not above 8 volts) should be used, the object being machined anodic, with a current of 80 to 100 amp. The speed should be 3.9 to 4.9 fps, the feed 16.5 to 49.2 fpm and the pressure 2.8 to 5.6 psi.

"USE OF OXYGEN IN THE PRODUCTION OF PIG IRON IN LOW-SHAFT FURNACES"

by K. SAUBERLICH, H. GROHMANN and G. RICHTER. (Translation No. 4498 from Neue Hutte, vol. 3, 1958, No. 4 (abridged)

Δ EXPERIMENTS were started in a small scale low-shaft furnace on the production of foundry iron with blast containing up to 35 per cent oxygen. These tests could be used only to predict the trends to be expected in large furnaces, not actual numerical results. As the pilot results were encouraging, further experiments were conducted in the Donauwoerth low-shaft furnace of the VEB Maxhutte at Wellenborn.

The effects of oxygen enrichment to 25 per cent increased production 25.9 per cent and cut coke consumption by 6.1 per cent. Iron composition was satisfactory.

The same furnace has produced spiegel from January, 1955, with oxygen-enriched blast on an industrial scale. With blast containing 25 per cent oxygen, production ran 20 per cent higher and coke consumption 4 per cent lower than in previous operation with normal blast. The influences of throughput time, screen analysis of burden materials and direct iron reduction on manganese recovery are detailed.

"POSSIBILITY OF ANALYZING STEEL FOR ALLOYING ELEMENTS IN ELECTRIC FURNACES WITHOUT TAKING SAMPLES"

by V. N. BALANDIN and S. L. MANDEL'SHTAM, P. N. Lebedev Institute of Physics, USSR Academy of Sciences. (Translation No. 4472 from Zavodskaya Laboratoriva, vol. 23, 1957, No. 5)

Δ EXISTING methods for rapid determination of alloying elements during heats waste time in sampling, conveying the sample to the laboratory, and preparing it for analysis. Replacement of chemical methods by spectrographic methods does not always save time. The possibility of spectrographically determining alloying elements in metals

during a heat without taking samples was investigated in a 2-ton electric furnace at the Central Ferrous Metallurgy Research Institute and in a 25-ton arc furnace at a steelworks. The spectrum of the arc was photographed with a portable spectrograph with a glass optical system set up on a stand 13 to 16½ ft from the source. During photography of the spectrum, the arc electrodes were lifted above the surface of the liquid slag.

Initially a number of spectra were made with a heavy-current arc burning in the 2-ton furnace. The object was to compare excitation conditions for the spectrum in this arc and in an arc excited between iron electrodes under conditions typical of spectroanalytic work. The spectra of the heavy-current arc basically consisted of iron lines. In addition, there are lines for a series of elements present in the metal and slag.

Next it was attempted to find a qualitative connection between the intensity of the lines of alloying elements in the spectrum of the heavy-current arc in the electric furnace and the content of these elements in the bath. The elements studied were manganese, chromium, silicon and calcium. The intensity of the manganese and chromium lines varies with the content of these elements in the bath. It was impossible to study the calcium lines, since they are practically saturated and do not vary in density with calcium content. Silicon, unfortunately, was present in the carbon electrodes; hence results for this element are not significant.

Next a series of experiments was run to find out whether the vapors of particular elements in the discharge came from the metal or the slag. It was found that manganese and chromium vapors enter the discharge from the metal and not from the slag. After these experiments, results were checked for reproducibility. The mean error is within experimental error.

In the experiments, the contents of elements in the bath lay between 0.1 and 1 per cent. From concentrations of 5 per cent upwards, the lines of most of the elements excited in the heavy-current arc are practically saturated. If less powerful sources of excitation were used, it might be possible to avoid saturation and to make measurements at higher concentrations.

The investigation was repeated on a 25-ton furnace at the Elektrostal plant. It was found that the ratio between the intensity of the lines and the background in the spectrum of an arc burning between electrodes in a fullscale furnace is quite satisfactory; however, the self-absorption of the lines is observed at considerably smaller concentrations of the alloying elements.

The experiments indicate the possibility of using direct spectrographic analysis of metal in an electric furnace without sampling.

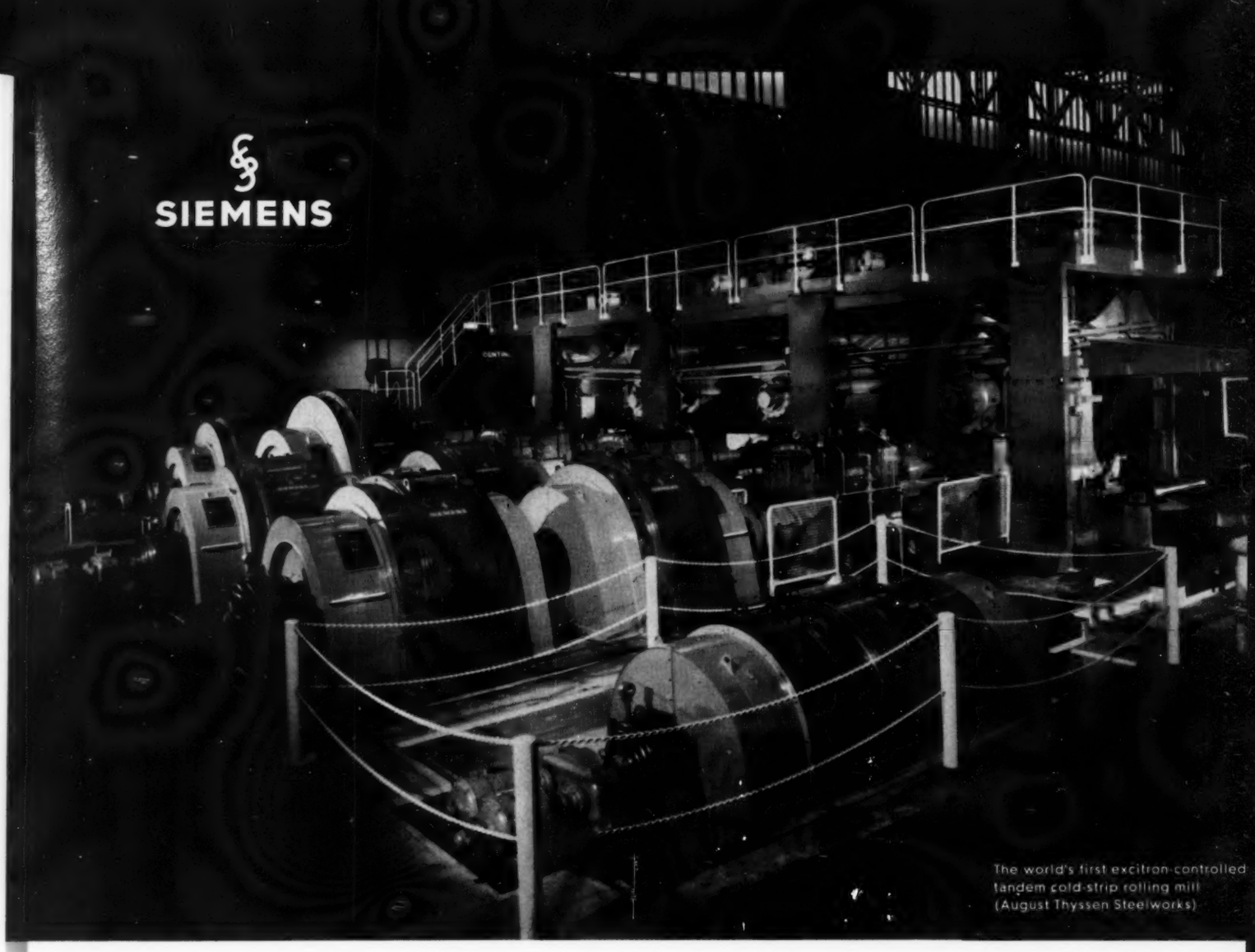
OTHER AVAILABLE TRANSLATIONS

"Effect of Melting Practice upon Properties of Stainless Steel," R. S. Belyakov. "Primenenie Vakuuma v Metallurgii," Moscow, 1958. Production of 18-8 stainless steel in vacuum induction furnaces for lowest possible carbon contents. Experiments on two groups of steel, in part titanium-stabilized; one group melted and poured at final pressures of 2 to 7 mm Hg; the other melted in air furnaces. Results presented as extensive tabular data and four graphs. Final furnace pressure needed to impart to 18-8, free from any stabilizing additions, complete resistance to intergranular corrosion and high resistance to corrosion in boiling 50 per cent nitric acid. Time of holding liquid steel under vacuum, as required for a maximum carbon content of 0.02 per cent. (Translation No. 4363)

"Kinetics of Steel Making," L. von Bogdandy, W. Dick and I. N. Stranski. Archiv Eisenhüttenwesen, vol. 29, 1958, No. 6. Carbon elimination: present status of knowledge with special reference to rate-determining step. Determination of wettability of refractory materials by liquid iron; rate of transfer of carbon monoxide and nitrogen into and out of iron melts; theory of carbon elimination with delimitation of influence of chemical reaction, diffusion and nucleation upon rate of reaction; application of theory to open-hearth and converter practices. Usefulness of theory for development of the rotor process. Dephosphorization: thermodynamics and kinetics; rate in basic converter, open-hearth furnace and rotor. Control of formation of brown fumes: kinetics of vaporization of iron and condensation, during blowing of the hot metal with air or oxygen; theoretical prediction as to possibilities of controlling the quantity and particle size of brown fumes and confirmation of predictions by plant-scale trials. (Translation No. 4473)

"Behavior of Liquid Iron and Steel in High Vacuum," W. A. Fischer and A. Hoffmann. Archiv Eisenhuttenwesen, vol. 29, 1958, No. 6. Comprehensive fundamental study of behavior of various companion elements of iron during vacuum melting at 0.00001 to 0.001 mm Hg in crucibles made of different materials. Experimental procedure and results. Crucible materials studied: electrically fused magnesia and corundum, stabilized zirconia, calcium zirconate, lime and dolomite. Impurities in these materials. Behavior of nonmetallic substances in liquid iron: nitrogen, hydrogen, phosphorus, arsenic, sulphur, carbon and oxygen. Behavior of metallic companion elements: Mn, Si, Cu, Mg, Ca, Al and Zr. Reactions between melts and crucible materials: melts containing 0.1 to 3.5 C; melts with 0.2 C; relationship between rate of desulphurization and carbon content. High-purity iron melts: crucible materials causing an increased or decreased oxygen content; deoxidation constant for alumina and zirconia crucibles. (Translation No. 4440)

"Comparison of Methods for Determination of Oxide Inclusions in Steel," V. A. Mchedlishvili. Zavodskaya Laboratoriya, vol. 24, 1958, No. 10. Comparative study of the two most reliable methods for anodic isolation of oxide inclusions from steel samples: the Klinger-Koch method and the Fitterer-Lukashevich-Duvanova method. Electrolytic apparatus by Klinger-Koch and chlorine apparatus for decomposing carbides in anode residues with purified chlorine gas and distilling off the chlorination products in vacuum. Failure of wet methods. Extent of agreement between the two methods of electrolysis in regard to oxide inclusions content; contents of silica, alumina, MnO, FeO; and oxygen content of steel. Method preferred by author for its greater simplicity. (Translation No. 4496)



The world's first excitron-controlled tandem cold-strip rolling mill (August Thyssen Steelworks)

Having considered all the pros and cons...

. . . you will agree that static-convertor-controlled drives are superior.

They are proving their worth from day to day.

Siemens static convertors are pumpless, grid-controlled steel-tank units of the excitron type. They can be controlled steplessly between the maximum positive and negative voltage limits, no matter whether the drive operates as a motor or as a generator. Thanks to the unitized system of construction plants can be assembled for any desired output.

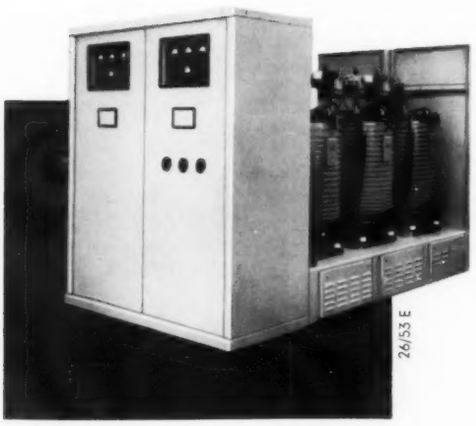
Here are some of the main advantages of the Siemens excitron convertors:

They require a minimum of floor space. Being light in weight, they need no expensive foundations and cranes.

They have no moving parts - consequently there is no bearing, brush or commutator maintenance. Only a minimum of spare parts need be kept in store.

Especially in conjunction with the recently developed transistorized control and regulating equipment the Siemens static convertors provide good, i.e. rapid and precise, control.

Any place, any time: Our experts are constantly at your disposal for advice on the planning and construction of rolling-mill drives.



Excitron convertor set with 6 single-anode tanks for d.c. voltages up to approx. 1,600 V and continous currents up to approx. 3,500 A (r.m.s.), maximum currents up to approx. 9,000 A (r.m.s.). Weight of a mercury-arc unit approx. 440 lb (200 kg) Weight of a complete convertor set approx. 6,600 lb (3,000 kg). Area of base 6 ft × 11 ft (1.8 × 3.3 m)

SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT

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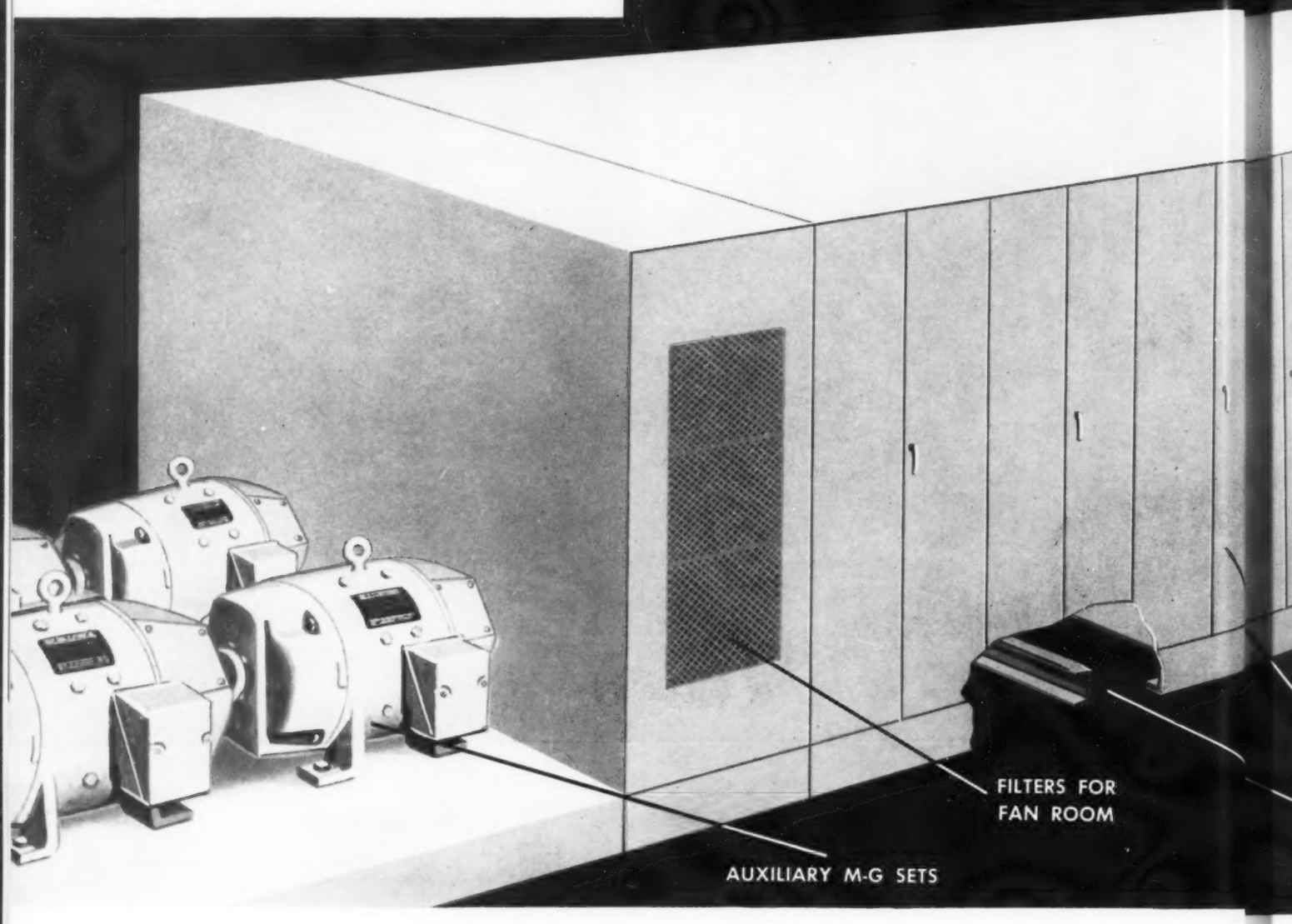
Greater efficiency — superior quality with advanced G-E mill controls



A NEW PRACTICE IN PROCESS-LINE CONTROL

G-E "packaged" motor-control rooms reduce

The latest innovation in modern steel-mill process-line control is General Electric's new "packaged" motor-and-control room. This novel design, developed jointly by General Electric and Jones and Laughlin Steel Corp., groups all controls and m-g sets into one compact centralized unit. The above unit will be installed at J&L's Aliquippa, Pa., works, as part of their continuing facilities-improvement program. Previously, the installation expense on this equipment often matched or exceeded the actual cost of the equipment. The new G-E motor-control room design cuts installation costs as much as 40 percent!

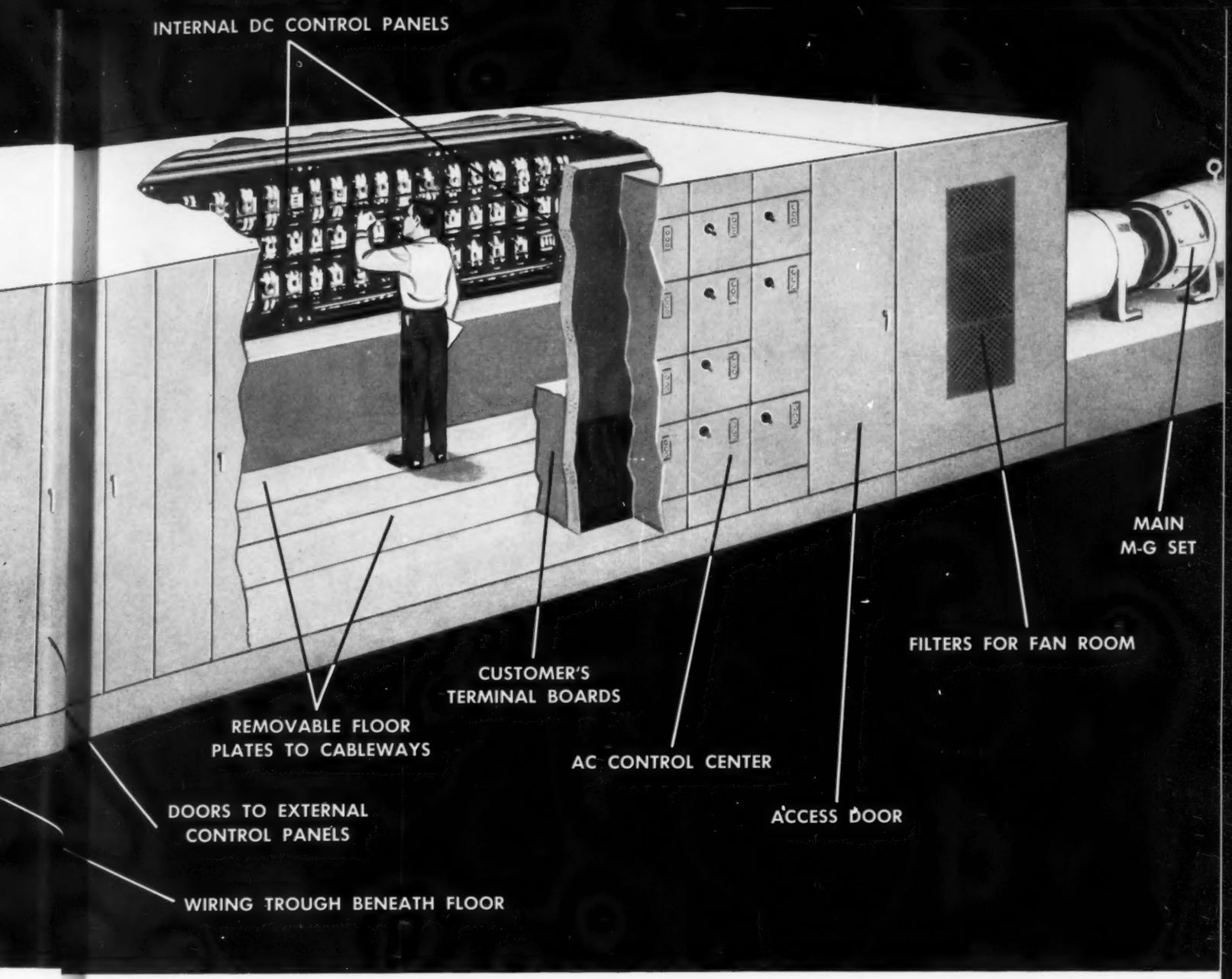
HERE'S WHY INSTALLATION COSTS ARE LOWER

Substantial savings on installation expenses can be realized through these features:

Independent control unit—The General Electric motor-control room is a completely co-ordinated, pre-assembled unit in itself, and in many cases, eliminates the need for a separate motor room. Since the motor-control room is self-contained, it may be located either near the driven equipment or in some previously unused area of the mill.

Field wiring is reduced by one-third or more—All internal connections are made and tested before the motor-control rooms are shipped. The only field wiring required is the connection of the power source and the leads to the operators' stations and the drive motors.

Construction engineering costs reduced—General Electric's grouped control concept enables the mill to know its conduit requirements much sooner. Thus, fewer, less-complex construction diagrams are needed, and actual construction can begin at an earlier date.



installation costs as much as 40 percent!

Common base minimizes installation time—This new "packaged" motor-control room, delivered on its own self-supporting platform, can be immediately set on a normal mill floor. It does not require expensive, specially-constructed foundations. With m-g sets built and shipped on a common base, the need to align them at the mill site is eliminated. In addition, regulating equipment is factory-tested prior to shipment, further expediting startup time.

For all the details on this new technique in process-line control, contact your G-E Sales Engineer today! General Electric Company, Industry Control Department, Roanoke, Virginia. 785-7

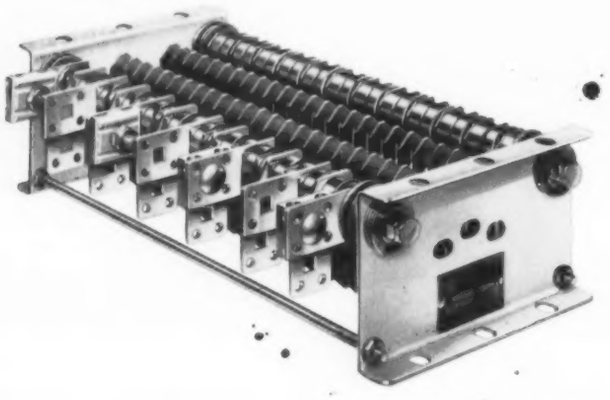
Progress Is Our Most Important Product

GENERAL ELECTRIC

P-G *Steel Grid Resistors*

ARE BY COMPARISON SMALL UNITS... *but so important to production*

- Steel Construction
- Mica Installation
- Corrosion Resistant
- Vibration Resistant
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals



Resistors represent only a small part of a charging machine, but the duties they perform are of the utmost importance to its operation. In this stage of steel making, a charging machine must be able to start, stop, reverse and change speed regularly and continuously during its operating cycle. P-G Steel Grid Resistors have been handling their part of this job with a remarkable service record in many plants. For continuous "Trouble-Free Service" on this and all other steel mill applications, specify P-G the ORIGINAL Steel Grid Resistor.

Write for Bulletin 500.

P-G has BOTH! STANDARD Resistors — WELDED Resistors

The Nonbreakable Steel Grid Resistor

P-G

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New!

Reliance Super 'T' V*S Drives put more power, faster response and greater overload capacity into a 35% smaller package!

New 50 hp. Super 'T' V★S control cabinet compared with 50 hp. old style drive on Reliance production line.

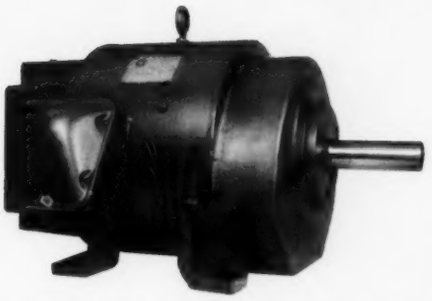
The secret is a new power unit, new controls, and the Super 'T' D-c. Motor

The new Super 'T' power unit packs extra punch into a smaller space. Like the Super 'T' D-c. Drive Motor, it uses Class B insulation and 60°C temperature rise design, permitting 100% overloads. Special control apparatus design has been engineered for the Super 'T' V★S. This systematic balance of power unit, drive motor, and controls forms a single, fast-functioning unit to provide a wide range of variable operating speeds from a-c. circuits.

40—150 hp. Super 'T' V★S available for immediate delivery. Contact your local Reliance Representative for delivery schedules of the complete line, 1—350 hp.

RELIANCE ELECTRIC AND ENGINEERING CO.

The Super 'T' V★S Drive, a complete power package, provides variable speeds from a-c. circuits



SUPER 'T' D-c. DRIVE MOTOR

OPERATOR'S PANEL

Wide range of operating speeds from a-c. circuits adds flexibility to existing production machinery. Speed changes are stepless and can be varied while equipment is operating or stopped.

Controls

New control relays, both a-c. and d-c. Field tested by three Reliance customers—for over 20 million operations without failure.*

Power Unit

Two-bearing power units are always in alignment, eliminate bearing and coupling problems.

Ventilation

Power unit cooling air is exhausted directly out of cabinet. Provides separate ventilation systems for controls and power unit. Controls are kept cooler, materially extending service life.

Insulation

Power units include new NEMA redesigned d-c. and a-c. machines. Units are smaller. Class B insulation with 60° C temperature rise allows more power in less space.

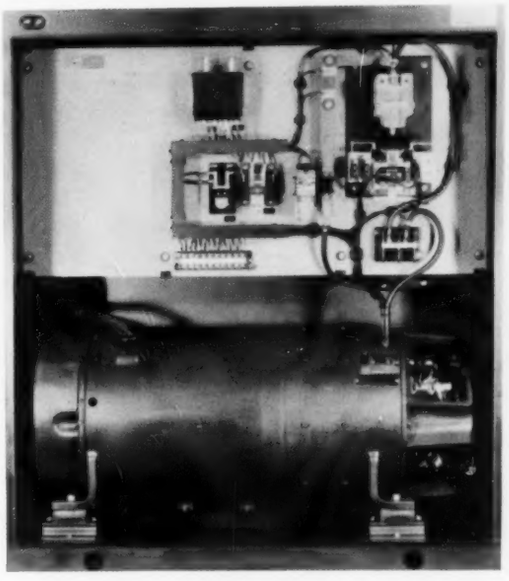
Drive Motor

Super 'T' D-c. Drive Motors give fast response to speed and load changes, take repeated 100% overloads of one minute duration without failure.

Design

Every component designed for matched performance. New motor controls, new power unit and new drive motor provide balanced operation of production machinery.

*Names on request.



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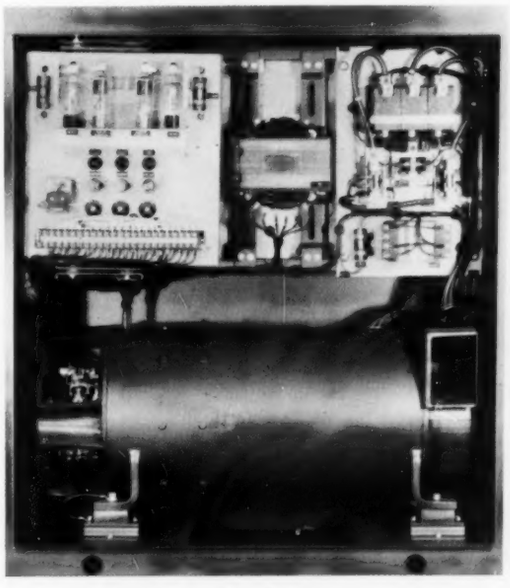
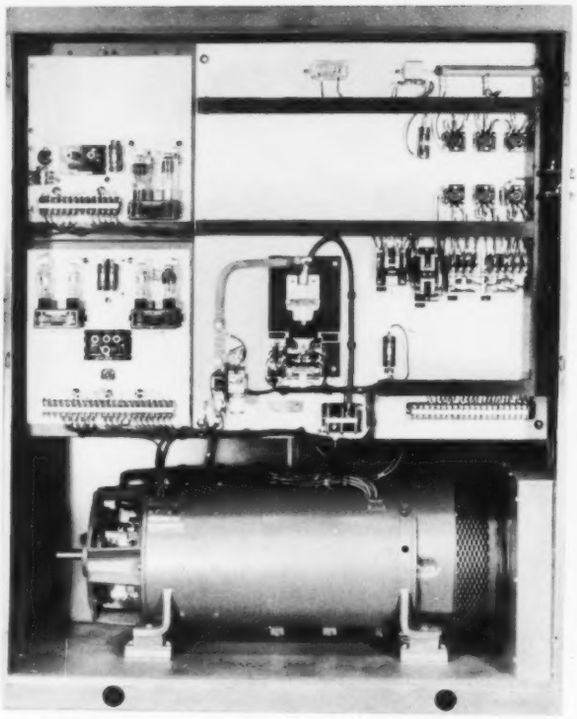


BACK

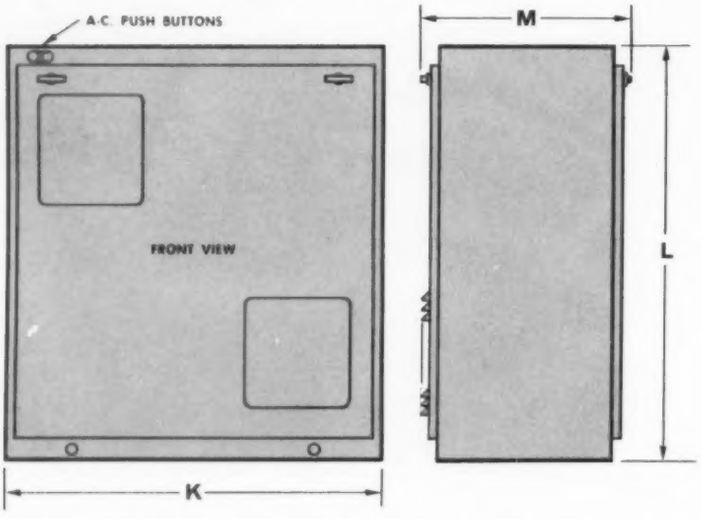
"Custom" Super 'T' V★S Drive for more flexibility, more automatic operation



Every function of the standard model and more. Custom units are designed to incorporate additional controls for engineered installations. Custom models, through the use of feed-back regulation, will provide complete system automation. Control panels are larger to accommodate controls for regulating speed, position, torque and any other operating variables.

Dimensions of Standard Super 'T' V★S Control

FLOOR MOUNTED, 1-150 V★S



Dimensions are in inches and correspond to letters shown.

V★S HP.	CABINET DESIGN	K	L	M
1-15	1SF	35	40	16
20-30	2SF	40	45	20
40-60	3SF	45	50	23
75-100	4SF	55	55	26
125-150	5SF	70	60	30

Product of the Reliance Electric and Engineering Company, manufacturers of a-c. motors, Master Gearmotors, Reeves Drives, Super 'T' D-c. Motors, generators, controls and engineered drive systems.

RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 17, OHIO
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MASTER R REEVES

RELIANCE

D-1618 Printed in U.S.A.

This installation consisting of seven hand-propelled cranes on a flexibly suspended runway is used for stripping wire blocks in a large steel mill.

Note how easy it is with the Cleveland Tramrail design to position the runway at any level or location desired. Likewise, it is extremely simple to dismantle and relocate the equipment to serve some other application, should such ever be necessary.

FLEXIBLE SUSPENSION

Assures Smooth Crane Operation

CLEVELAND Tramrail's unique flexible suspension method of supporting crane runways prevents binding of wheels on the tracks and assures smooth easy rolling operation, regardless of location of the load on a crane bridge.

The floating runways compensate automatically for normal skewing or twisting of crane bridges.

This is one of the reasons why hand-propelled Cleveland Tramrail cranes can be used for so many jobs where motor-driven cranes would otherwise be required.

Operation is so easy that Cleveland Tramrail guarantees a starting effort of 15 lbs. and running effort of 10 lbs. per ton weight.

Write for free copy of illustrated booklet No. 2008, "Engineering and Application Data".

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 5012 E. 290 ST. • WICKLIFFE, OHIO

proved
SPRAY NOZZLE
design

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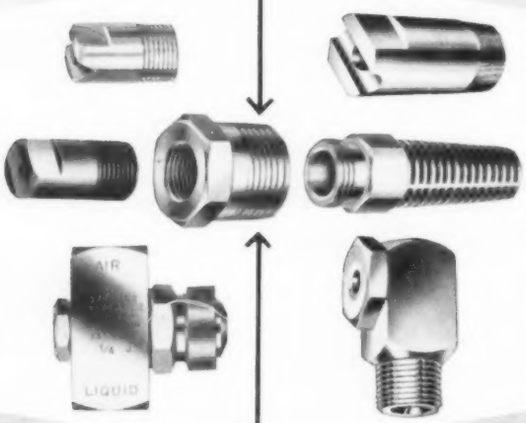
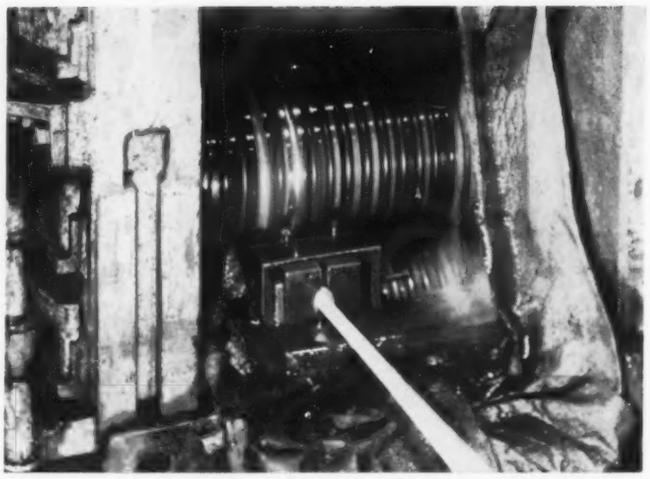
• DESCALING • HOT STRIP COOLING • ROLL COOLING • COOLING SLABS—INGOT MOLDS — OPEN HEARTH TUNNELS — PIGS • COKE CHEMICAL PROCESSING • LUBRICANT SPRAYING • AIR AND GAS WASHING

Whatever the application you will find Spraying Systems Spray Nozzles provide noticeable improvement in spraying operations . . . and often materially lower cost. Proved by performance. Supplied in a complete choice of types and capacities for selection of spray characteristics exactly as needed. Your inquiry is cordially invited.



SPRAYING SYSTEMS CO.
3262 Randolph Street • Bellwood, Illinois

For complete information write for Catalog 24 and special data sheet folder "Steel Mill Applications".



Near-white-hot rod enters roller guide housing, and forming rolls beyond. Colmonoy hard surfacing rebuilds worn guides, gives them longer life than before.

Colmonoy Cuts Roller Guide Reclamation Cost

Hard-surfacing alloys that are easy to apply save welding time. And it follows that finishing time is also reduced—easy-applying alloys produce smoother deposits. Time is money, and the maintenance department of a large stainless steel bar mill saves money by using Colmonoy No. 6 alloy to reclaim worn roller guides. With Colmonoy they reclaim three guides in the time it took to do one previously.

The superior wear-resistance of Colmonoy No. 6 added more savings by extending even further the service life of the guides. All roller guides in this plant are reclaimed with Colmonoy—again and again, indefinitely.

Colmonoy alloys are being used in many mill operations: on plate guides, edger rolls, journal sleeves, and coolant-pump parts. Write for complete information.

Smoothness is the notable characteristic of these Colmonoy-protected guides prior to finishing.

Roller guide being overlaid with Colmonoy No. 6 rod. Work rotation is operator controlled.

Ready for further service are these finished guides with mirror-bright Colmonoy surfaces.

HARD-SURFACING AND BRAZING ALLOYS

WALL COLMONOY
CORPORATION
19345 John R Street • Detroit 3, Michigan

BIRMINGHAM • BUFFALO • CHICAGO • HOUSTON • LOS ANGELES
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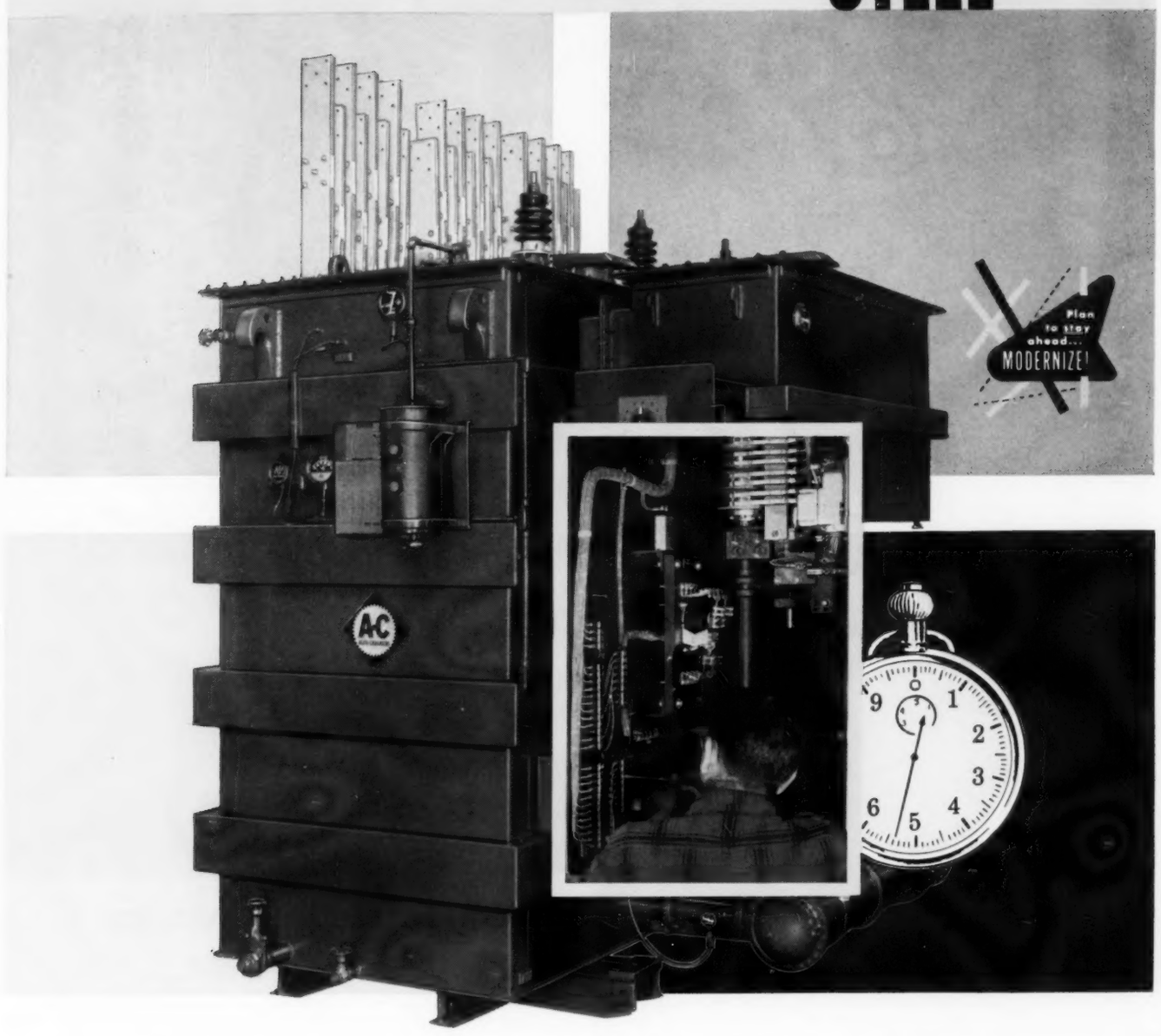
ALLIS-CHALMERS . . . in step with **STEEL**



Tap sequence changed **from the floor** IN MERE MINUTES **on Allis-Chalmers furnace transformers**

Selectoheat control, an exclusive feature of Allis-Chalmers furnace transformers, slashes downtime from hours to minutes. Convenience is the secret behind this outstanding time conservation. Tap leads are brought directly to a motor-operated tap changer in a separate eye-level, work-level compartment. Gone are the hazards associated with working on top of the transformer. Main tank need only be opened for periodic inspection. With the under-oil terminal boards eliminated, transformer height has been reduced.

Call your A-C man for details, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-5951-1S

Selectoheat is an Allis-Chalmers trademark.

This man is tabling downtime indefinitely with SKF's new steel pillow blocks

He's cutting bearing maintenance to a minimum yet drastically reducing the chances of table downtime! For he's equipping the mill tables with SKF's new SMT Steel Pillow Blocks with self-aligning spherical roller bearings.

The split construction design of these new pillow blocks makes it possible for rolls to be removed without disturbing base alignment. The non-rubbing, labyrinth-type seal effectively keeps out scale and water and is not affected by high temperatures.

The Type "C" Spherical Roller Bearing gives him the highest capacity available in any self-aligning roller bearing. This high capacity is available despite angular misalignment caused by heat warpage of the table structure or other factors promoting table misalignment.

He'll save with direct, center lubrication, too . . . because a lubricating groove is provided around the circumference of the outer ring of SKF sphericals with equally spaced holes drilled in the ring connecting the groove to the center of the bearing. Grease moves around the groove and through the holes which channel it directly to the center of the bearing.

Why not make the change-over to SKF Steel Pillow Blocks yourself? Write for Catalog #447.

7821

Spherical, Cylindrical, Ball, and "Tyson" Tapered Roller Bearings

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

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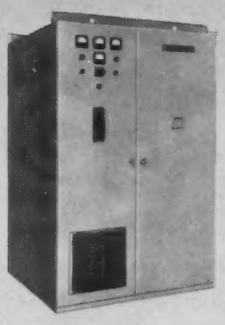
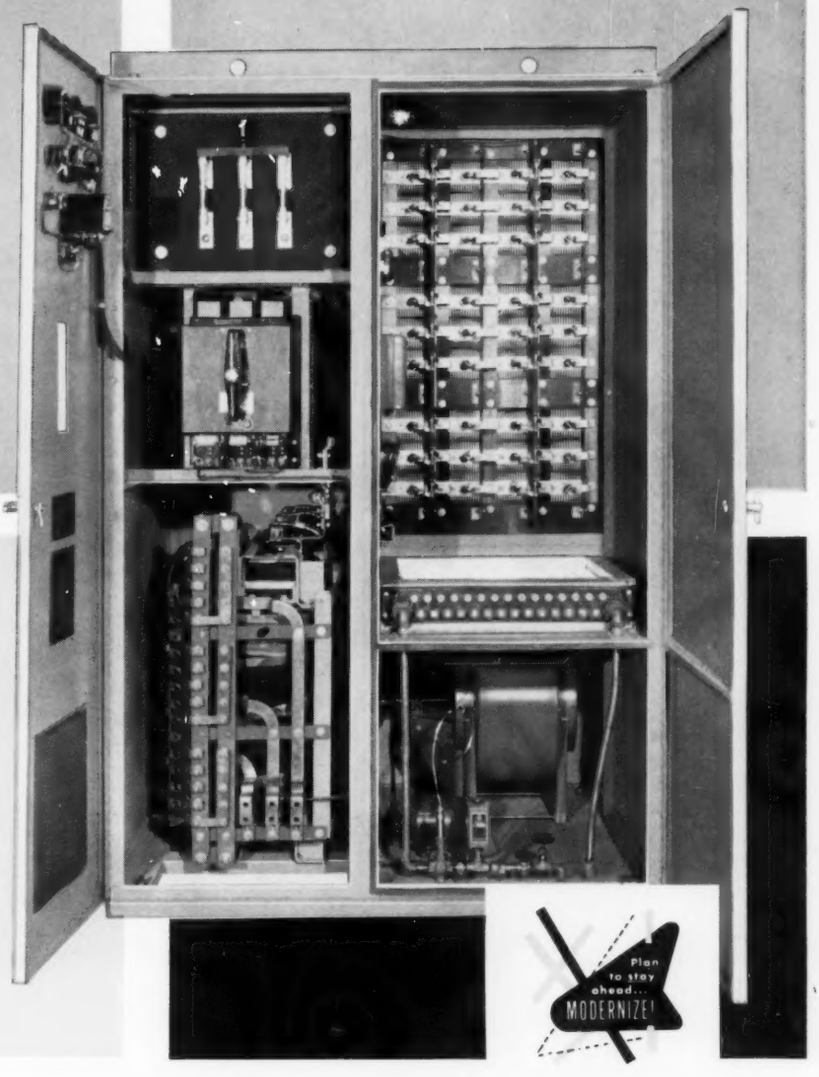
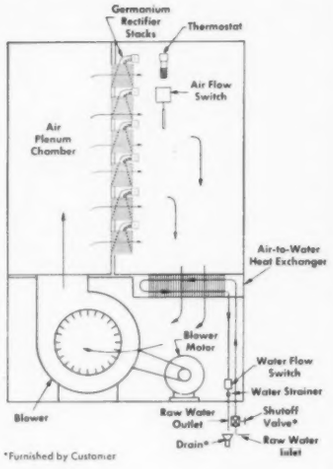
ALLIS-CHALMERS...in step with **STEEL**



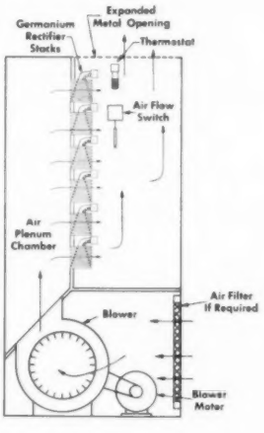


CHOICE OF COOLING SYSTEMS



*Furnished by Customer

A recirculating air system featuring an air-to-water heat exchange is employed where atmosphere is corrosive or dusty.



A simple air-cooling method is recommended for use in near normal atmospheres and where water is not available.

CORRECT APPLICATION

is the key to semi-conductor rectifier efficiency in the steel industry

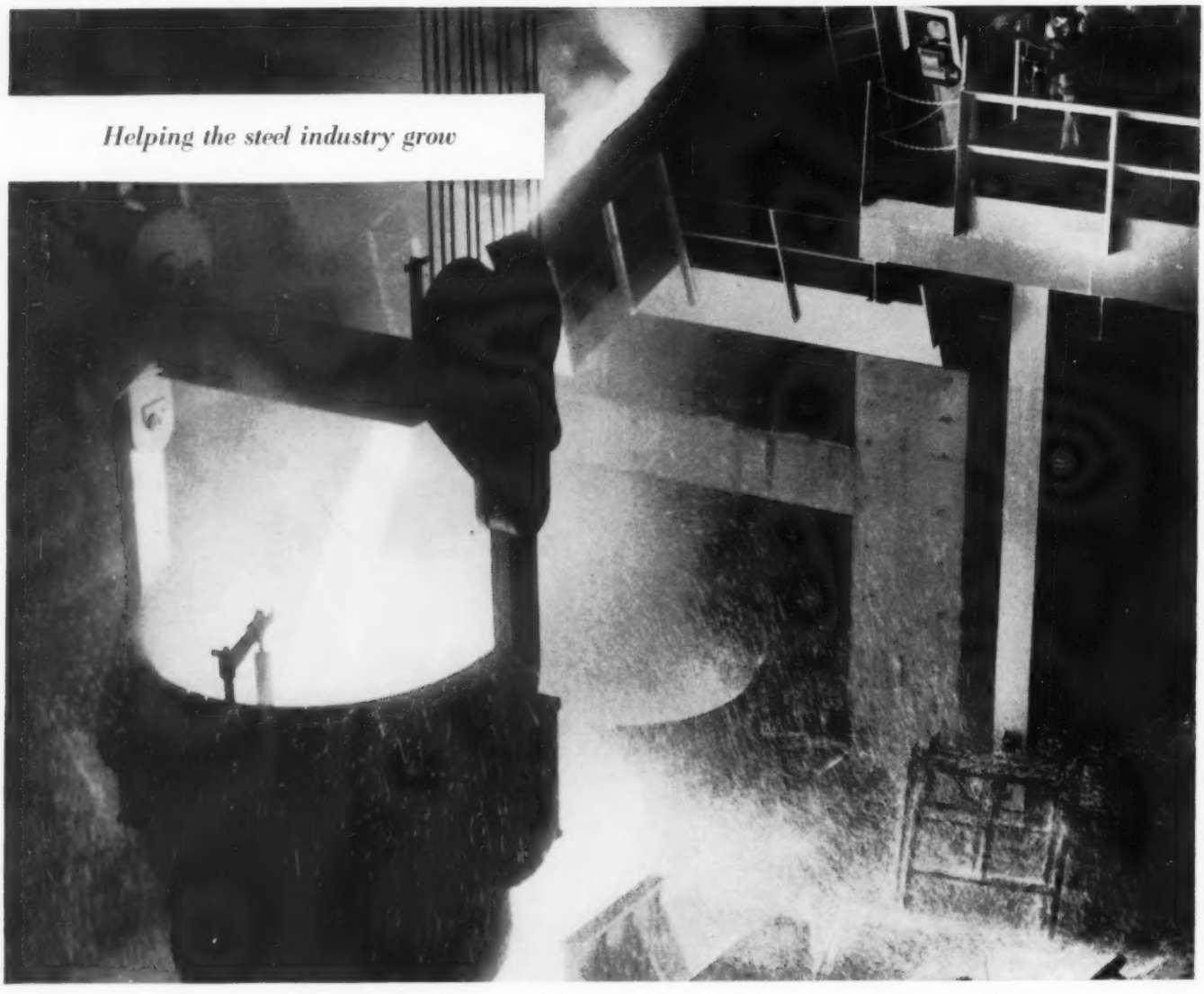
Sure, you're looking for the high conversion efficiency, low maintenance and simplified operation associated with semi-conductor rectifiers. And you'll get all these advantages — and more — if the semi-conductor rectifier is a right-for-the-job installation.

Your local Allis-Chalmers man will be glad to tell you whether *or not* a semi-conductor rectifier is best for your specific steel industry operation. He can afford to be completely unbiased in his approach to your problem because Allis-Chalmers makes *all types* of power rectifiers. At his disposal, and yours, are vast research and engineering facilities. Behind his recommendation is the world of assurance found in the fact that Allis-Chalmers has been developing, building and applying rectifiers in the steel industry for almost 25 years.

For complete information, call your A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

A-5950-1S **ALLIS-CHALMERS**

Helping the steel industry grow



Tapping a heat of steel from the new 100-ton electric furnace, one of the facilities added in the major expansion program of Lukens Steel Company.

Responsibility on the job

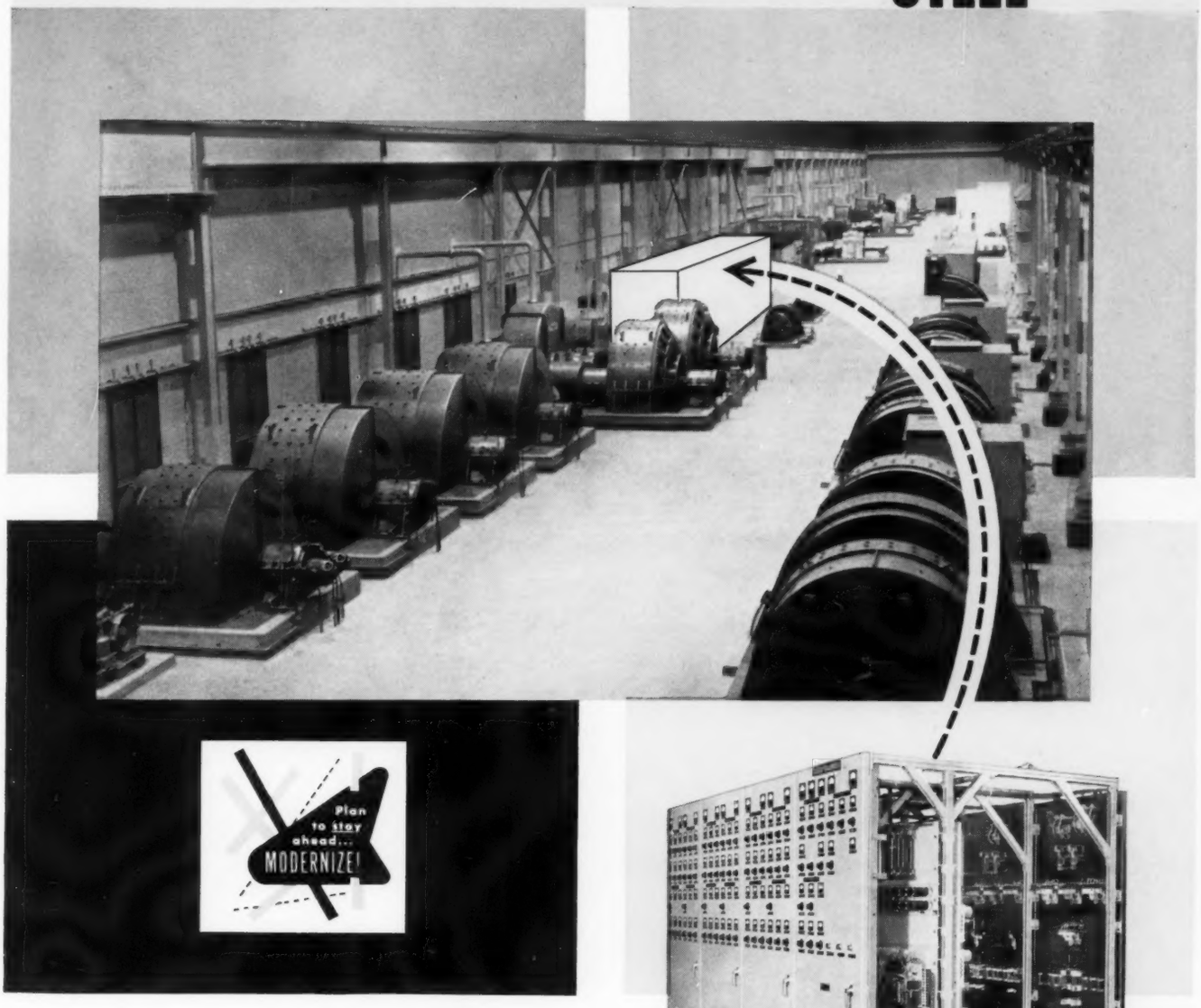
Responsibility for engineering, purchasing, cost control and construction in the just-completed expansion program of Lukens Steel Company, Coatesville, Pa., was assigned to United Engineers. The project included such facilities as 12 new soaking pits, the deepest in the United States—a new 100-ton electric furnace—and a new four-high 140-inch slabbing mill with giant back-to-back rectifiers supplying the d-c current for the motors. This is the first such installation in this country.

Whatever *your* requirements—rolling mills, slab heating furnaces, sintering strands, desulfurizer stations, oxygen plants, power plants, coal handling equipment—the broad, flexible range of our services can be precisely adapted to your needs. Our background of 75 years' experience as designers, constructors and consulting engineers assures you of maximum return on each dollar.

UNITED ENGINEERS

& Constructors Inc • U.E.&C. (Canada) Ltd. • New York • PHILADELPHIA • Chicago

ALLIS-CHALMERS . . . in step with **STEEL**



NEW

Regulators modernize mill

Yield has been increased . . . scrap decreased as width and thickness of strip are held to closer tolerances.

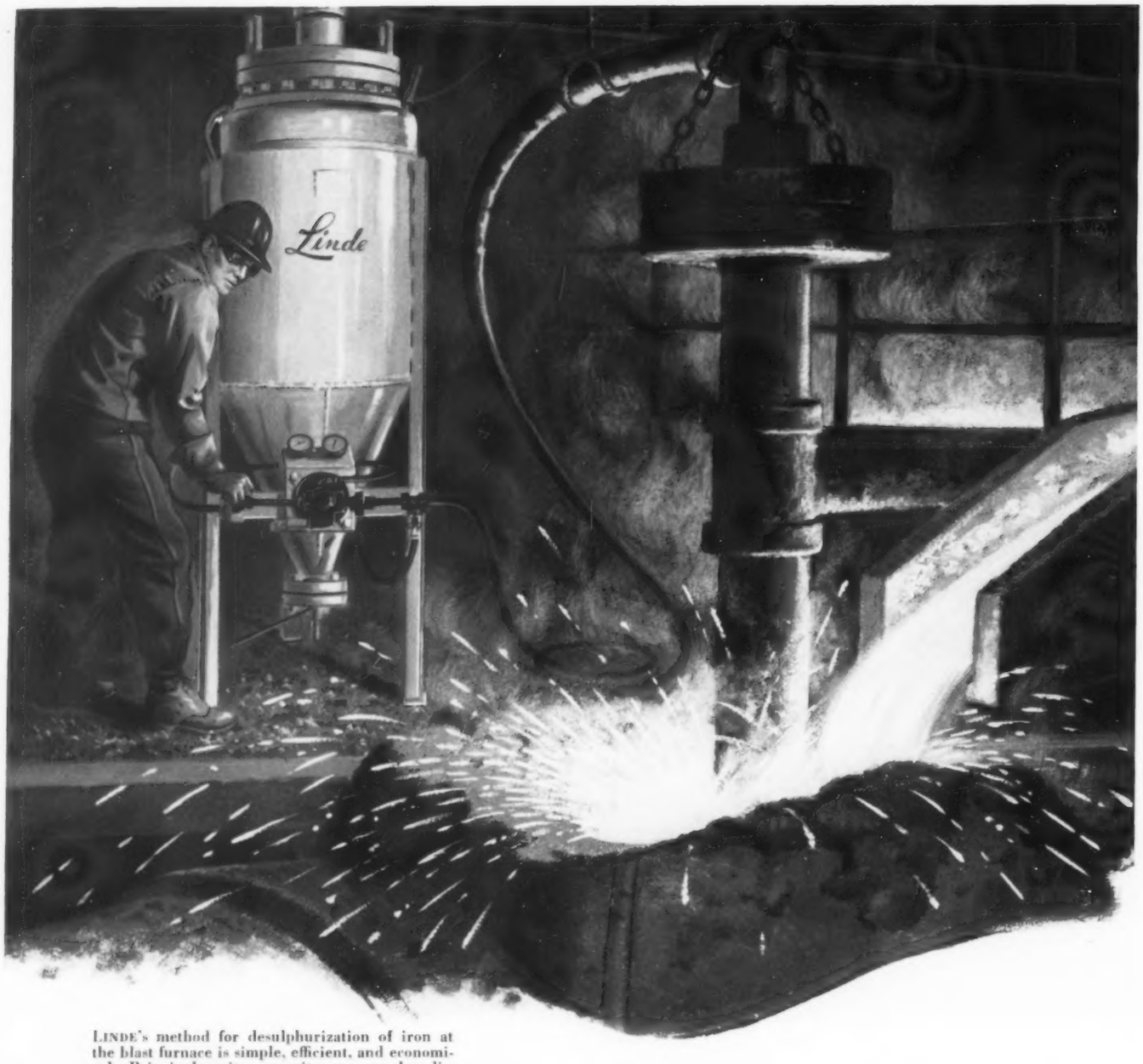
Nothing was changed except the control in this large eastern mill. The motor room of this 68-inch hot-strip mill looks practically the same as it did five years ago, but it's all new in operation.

New Allis-Chalmers stand speed regulators and bus voltage regulators featuring magnetic amplifiers make the difference. They were specifically engineered to provide a high gain, fast response system for consistent performance of the mill so that more high-quality product can be rolled.

Find out what modern control can do for your operations. Contact your nearby A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-5964-15



LINDE's method for desulphurization of iron at the blast furnace is simple, efficient, and economical. Principal units are nitrogen supply, dispenser, and injection tube.

MAKE OFF-CASTS MEET SPECIFICATIONS . . . WITH

Metallurgical Carbide from LINDE

With LINDE equipment and UNION calcium carbide, the sulphur content of molten pig iron can be effectively and economically reduced. When you use the LINDE method, you get these advantages: No noxious fumes . . . dry slag does not attack refractory materials . . . treatment is fast, easy to operate and control . . . results are predictable and uniform.

The LINDE equipment includes a large carbide dispenser, adequate nitrogen supply, and graphite injection tube. Fine mesh carbide, carried by a stream of pressurized nitrogen, is injected deep in the hot metal. Using this LINDE method, you eliminate unnecessary pigging costs. And you can gain even greater savings by buying metallurgical carbide in bulk from LINDE.

If you would like to know more about LINDE's improved desulphurization methods and equipment, write today. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

Linde
TRADE-MARK

UNION CARBIDE

The terms "Linde," "Union," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

ALLIS-CHALMERS...in step with **STEEL**

Plan to stay ahead... MODERNIZE!

An open motor did what no other motor could... in a mudbath

This Super-Seal motor with *Poxeal* insulation and protected bearing was not fouled by mud. An Allis-Chalmers customer, in a frequently flooded area, required a motor that could readily start even after prolonged immersion in mud.

The "dirtiest mud available" was used in conducting the successful tests in the A-C Motor Laboratories.

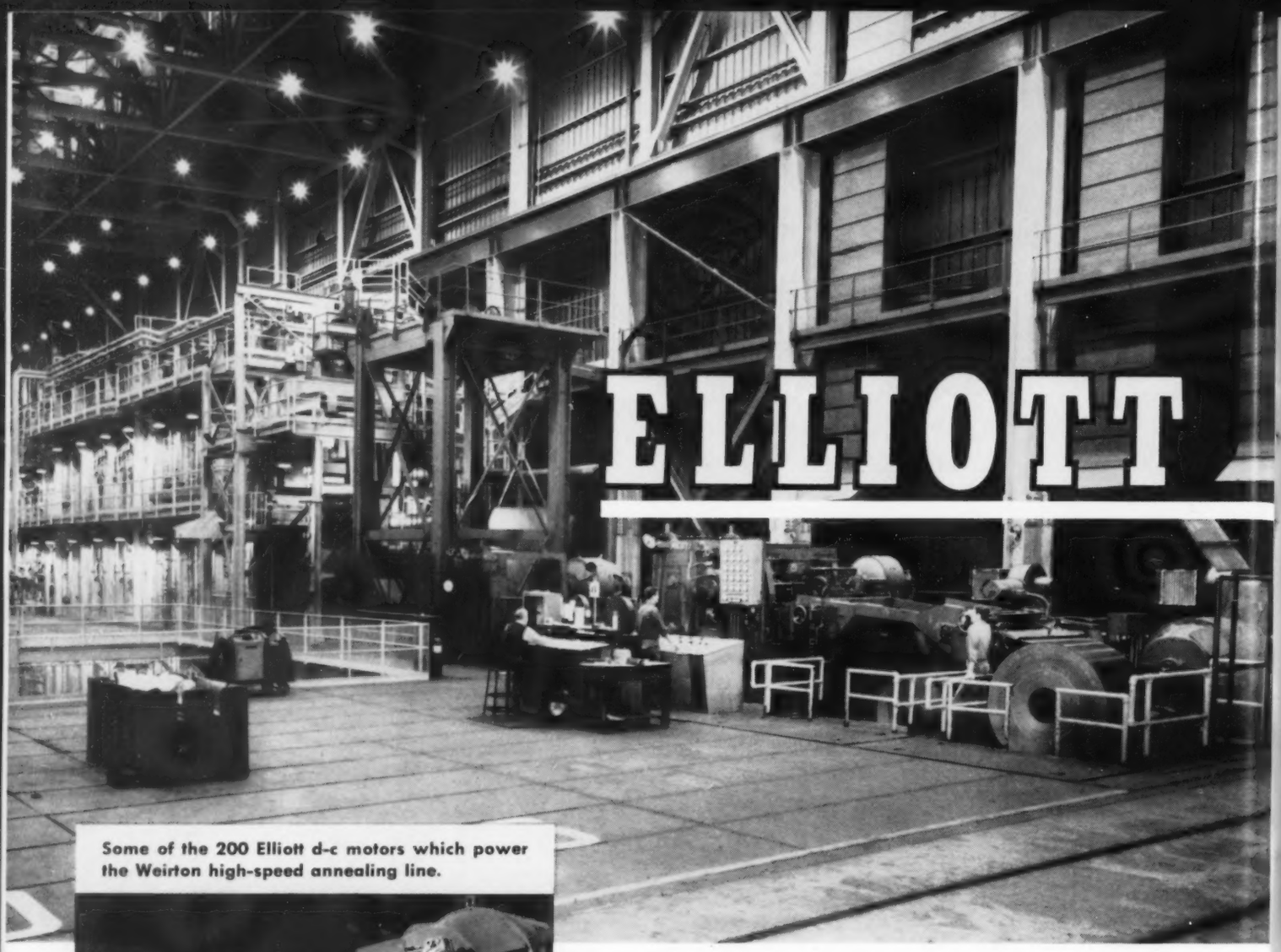
Motor user requirements like this form the basis for A-C pioneer-leadership in motor development. Motor buyer needs created the most complete line of integral-horsepower motors in industry. Induction, dc, wound-rotor, synchronous, gear, tube-type and *Synduction* motors, and now *Super-Seal* motors! And, if these lines don't fill your need, A-C engineering excels in special design.

Motor users in the iron and steel industries can benefit from this pioneer-leadership. Contact your A-C representative or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

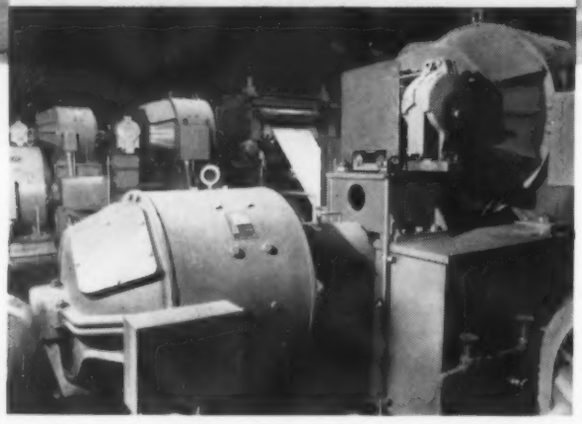
Super-Seal, Poxeal, and Synduction are Allis-Chalmers trademarks.

ALLIS-CHALMERS A-C

A-1005-IS

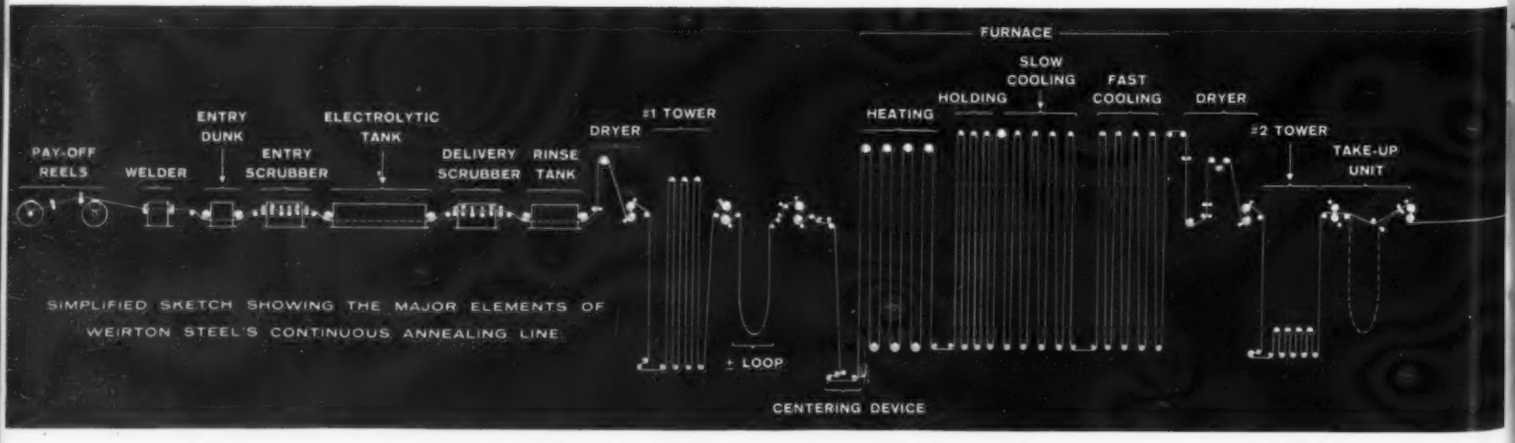


Some of the 200 Elliott d-c motors which power the Weirton high-speed annealing line.



From start to finish—

ELLIOTT equipment provides precise coordination of complex electrical drives



SIMPLIFIED SKETCH SHOWING THE MAJOR ELEMENTS OF WEIRTON STEEL'S CONTINUOUS ANNEALING LINE

(Left)
Over-all view of annealing line from delivery end. Approximately 200 Elliott motors and generators power this huge processing line.

CONTROL SYSTEM (right) was designed by Elliott Industry Engineering Department in cooperation with Weirton Steel Company engineers.

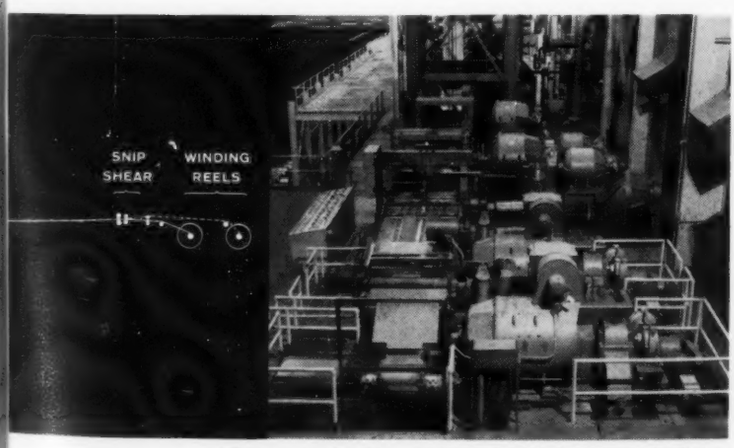
equipment drives Weirton's new high-speed continuous annealing line

HARD, brittle cold-rolled strip steel races through the new Weirton 560-foot cleaning and annealing line at record-breaking strip speeds of up to 2000 feet per minute. It emerges soft, ductile and workable. Capacity at top operating speed is 60 tons per hour.

Processing thin gage, brittle material at high speeds, and without damage or interruption, obviously requires precise coordination of the various electrical drives. Elliott supplied all of the rotating electrical equipment for this gigantic facility—including more than 200 motors and generators. The control system which achieves the necessary coordination was also designed by the Elliott Industry Engineering Department in cooperation with Weirton Steel Company engineers.

Additional Elliott steam and electrical equipment, installed at Weirton Steel Company, (a division of National Steel Corporation) over the last 40 years, includes turbine-driven blast furnace and coke oven compressors, mechanical-drive turbines, barometric condensers, deaerating feedwater heaters, and water strainers.

Bulletin Q-23A, "Elliott Equipment for the Steel Industry and Related Industries," illustrates many other outstanding examples of Elliott's experience in coordinating electrical drives. For your copy, address Elliott Company, Jeannette, Pa.



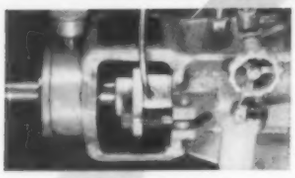
The two winding reels at the delivery end of the line are each driven by a 200-hp, 200/1200-rpm Elliott motor.

ELLIOTT Company

Q9-1

SYNTRON

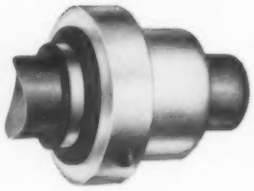
Mechanical SHAFT SEALS

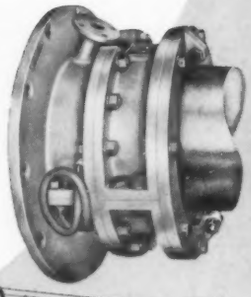


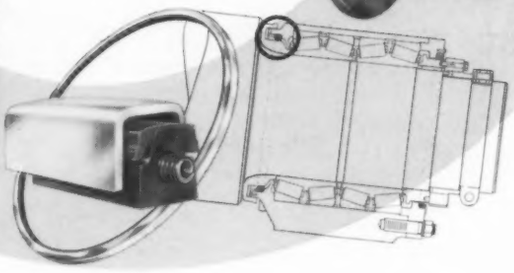
on vacuum pump

on centrifugal pump

on condensate pump







Eliminate periodic repacking and maintenance

SYNTRON Mechanical Shaft Seals have many applications and are widely specified in the steel industry. They effect a dependable, leak-free seal around rotating shafts without damaging the shaft.

Positive, leak proof operation—sealing surfaces are precision lapped for perfect contact—assures a perfect seal around the rotating shafts of pumps, turbines, compressors, engines, roll necks and propeller shafts. They are made in sizes for shafts from 1/4" to 48".

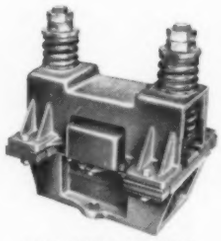
You can apply SYNTRON Shaft Seals to slow or high speed shafts, to seal hot, cold, corrosive or abrasive liquids, synthetic fluids, oil, toxic gases, sea water or just plain water.

SYNTRON Shaft Seals are compact, self-contained, self-lubricated units, ready to install—do not require periodic adjustment or maintenance.

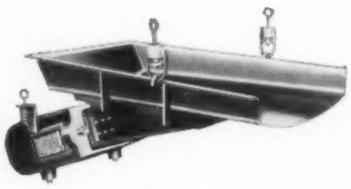
There is a SYNTRON Shaft Seal for every sealing problem.

Write for detailed information.

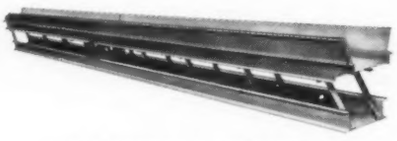
Other SYNTRON Equipment of proven dependable Quality



BIN VIBRATORS



VIBRATORY FEEDERS



MECHANICAL VIBRATING CONVEYORS

VIBRATING SCREENS

SELENIUM OR SILICON POWER UNITS

SYNTRON COMPANY

699 Lexington Avenue — Homer City, Penna.

2 New Bolted LIFTING MAGNETS by EC&M

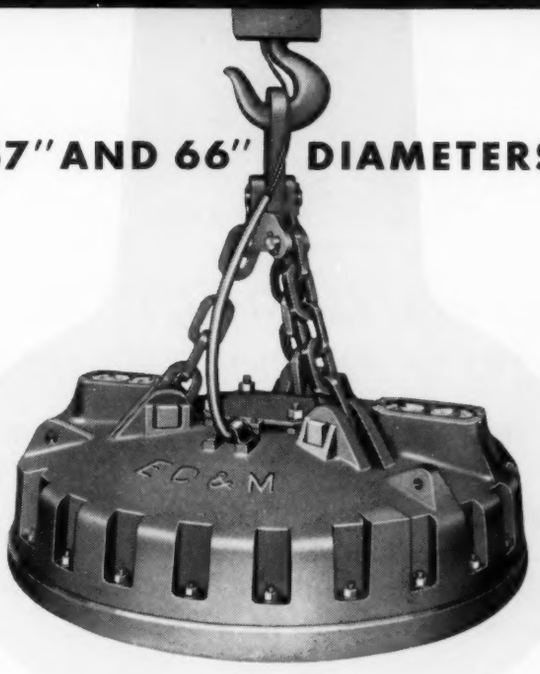
57" AND 66" DIAMETERS

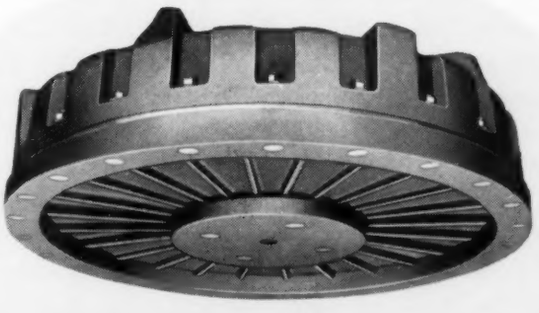
New throughout, these EC&M **Type SB Lifting Magnets** have many improvements over previous-design bolted magnets. They are mechanically stronger, have improved coil construction, and high lifting capacity due to a better magnetic path. Tapered-head, through bolts simplify field replacement of worn pole shoes... permit quick access to coil.

Strap aluminum coil winding is firmly anchored by top-plate held by bolts and screws. Continuous welds seal coil spool in magnet case and make it water-tight. Welds are easily ground or chipped off for field removal of coil.

Coil-leads terminate in separate chambers, 180° apart. The magnet is freed of moisture and completely filled, through these two chambers, with self-polymerizing, insulating compound.

Chains, the same as used on large EC&M ALL-WELDED Magnets, are of 3-leg design with links of cast manganese steel terminating in a forged crane link for easy hook-on.





EC&M BOLTED MAGNETS complement the complete line of EC&M ALL-WELDED Magnets • For all the facts, Write for Bulletin 1300 SB

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

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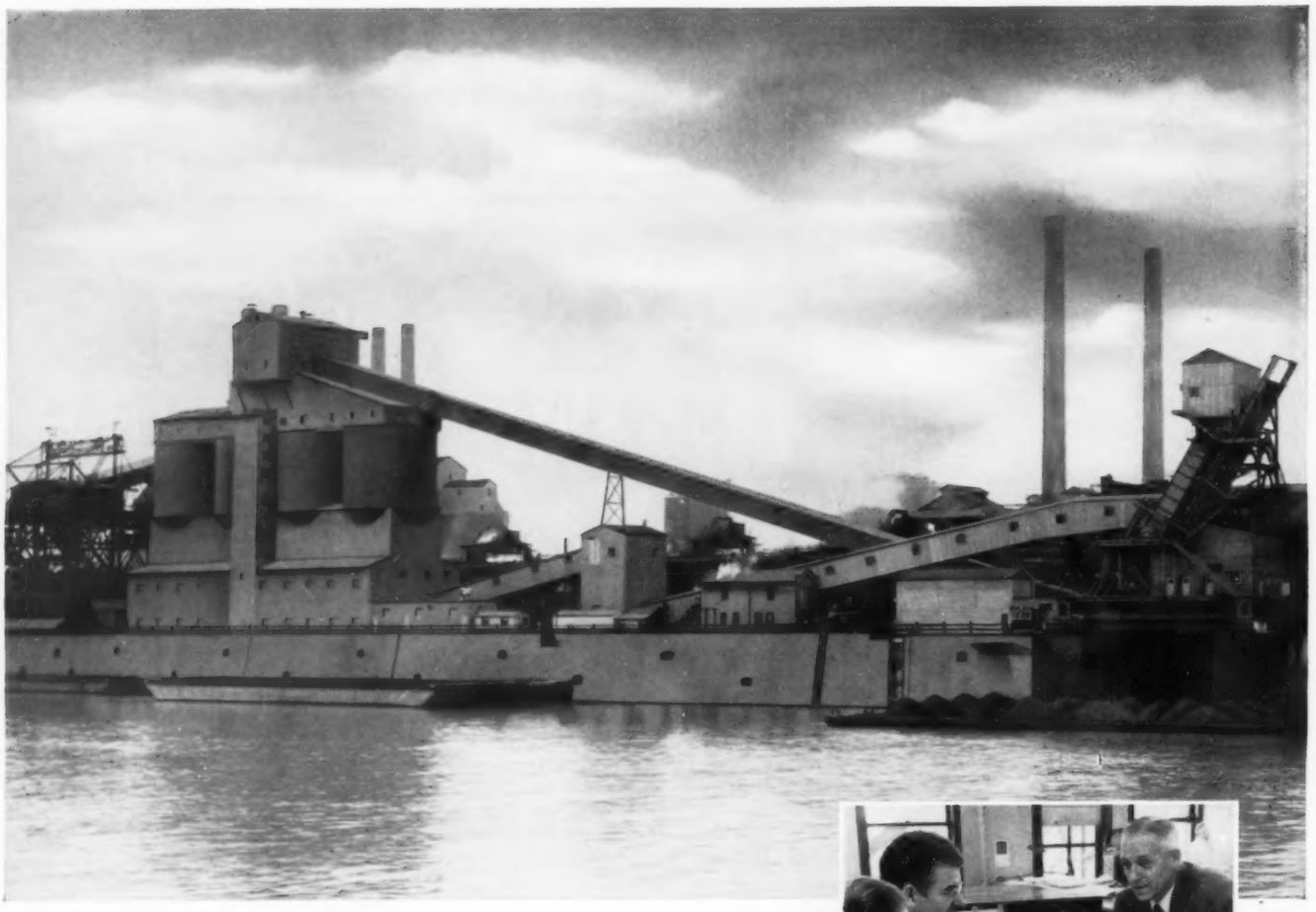
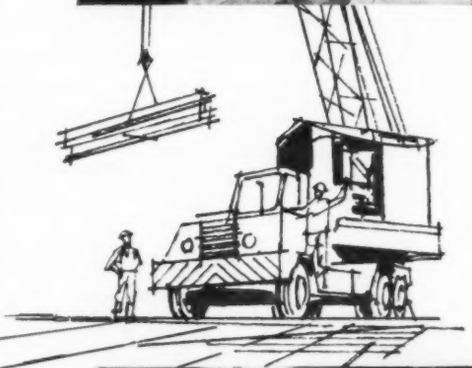


CAPACITY! FLEXIBILITY! ECONOMY! PERFORMANCE! . . . everything you want in a material handling plant

You determine exact performance specifications for the material handling plant you want. Roberts & Schaefer can meet your specifications, however exacting, with all required processing, distributing and storage systems. It takes specialized experience, creative engineering skills and strong resources to deliver . . . as Roberts & Schaefer can and does. You can depend on R&S for any portion of the project or for the complete job — design, engineering, fabrication, construction.



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ROBERTS & SCHAEFER Company

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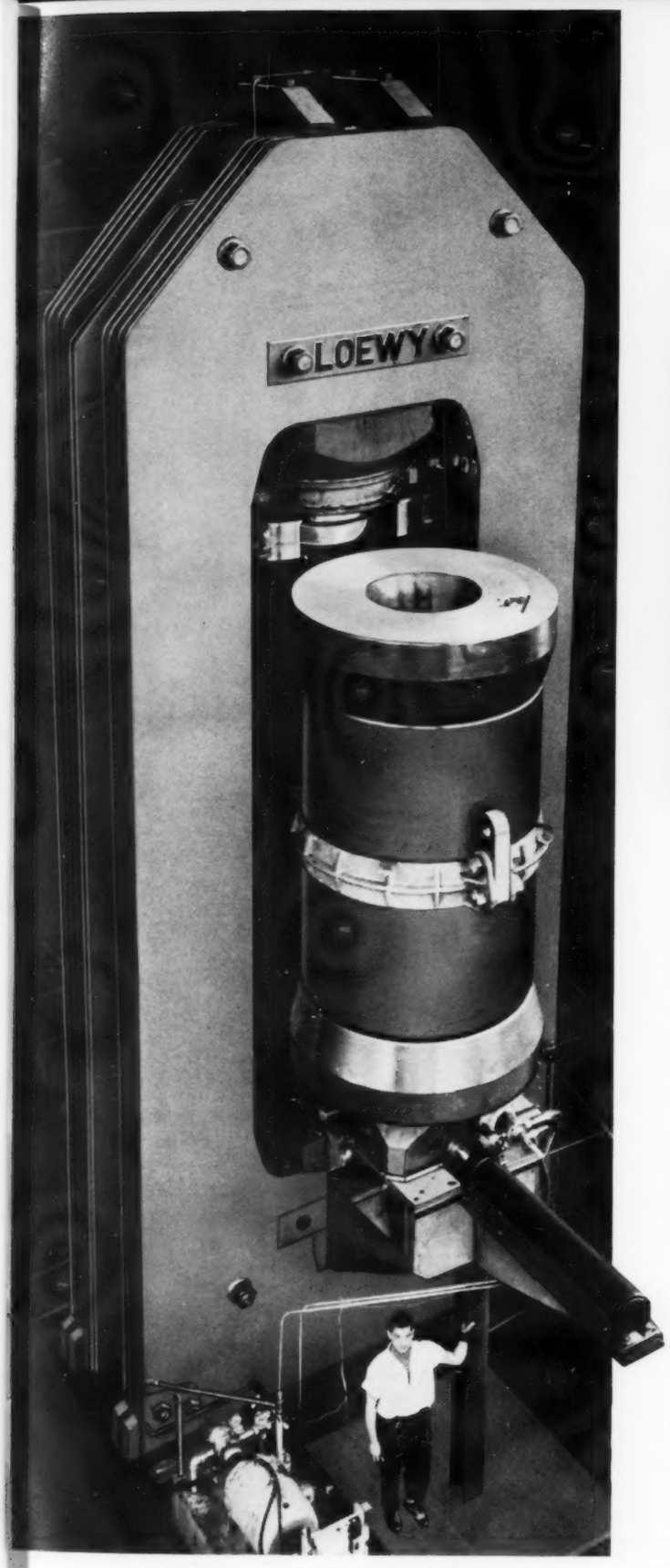

View of Loewy high-pressure vessel showing pressure cylinder withdrawn for loading

Tested like a patient's heartbeat and blood pressure in surgery...

THIS HUGE pressure vessel—believed to be the largest ever built—was conceived for the extremely high operational requirements of 30,000 psi and test pressure of 45,000 psi.

Designed and built by Loewy-Hydropress Division of Baldwin-Lima-Hamilton for the United States government, this unusual piece of equipment required an elaborate testing procedure comparable in precision to the observation of a patient's heart during a surgical operation.

More than 80 SR-4® strain gages, products of B-L-H's E&I Division, were located at all critical points of the structure. Over 1500 readings were taken of the strains and stresses developed during loading the vessel up to 45,000 psi and down again.

Measurements obtained during this procedure were used for both the analytical computations and the graphical plotting of stress-strain diagrams required to describe the successful acceptance tests.

Fabrication and testing were performed entirely at B-L-H's Eddystone Division—another demonstration of the integrated interdivisional facilities of the Baldwin-Lima-Hamilton Corporation.

Loewy coordinates the teamwork of its B-L-H fellow divisions in many technical fields. For creative engineering, research and development in the area of high-pressure hydraulics, direct your inquiries to Loewy-Hydropress Division, Dept. C-5.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

NATIONAL stopped brush breakage!

TRADE-MARK

DOWN-TIME COULD HAVE COST THIS POWER COMPANY A FORTUNE!

"RED" BLACKBURN

Power companies kept reporting threading and grooving of the steel field rings on giant turbine generators. The result was eccentric rings and *severe brush breakage,* says "National" Carbon Brush Man "Red" Blackburn.

And, he continues, a turbine off the line for reconditioning can cost a fortune in power replacement — not to mention repair expense.

"Red" suggested using "National" Grade 634 Brushes. Comparative tests showed this brush eliminated threading, grooving and resisted breakage and chipping when applied to eccentric rings.

Do you have a brush problem? Call *your* "National" Brush Man. Or, write to National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd St., New York 17, N. Y.

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Photo Courtesy Milwaukee Gear Company

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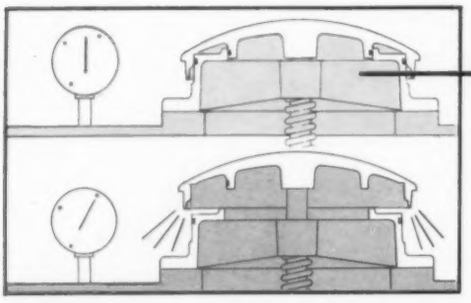
FURNACE TRANSFORMER NEWS:

The space-saving rectangular tank now standard for all Pennsylvania Furnace Transformers saves as much as 25% in overall floor space. New vaults can be smaller, less costly. Existing vaults will accommodate replacement transformers of greater capacity.

Two recently developed *time-saving* features are provided with the new space-saving rectangular tank. They are:

1 FULLY AUTOMATIC PRESSURE-RELIEF DEVICE

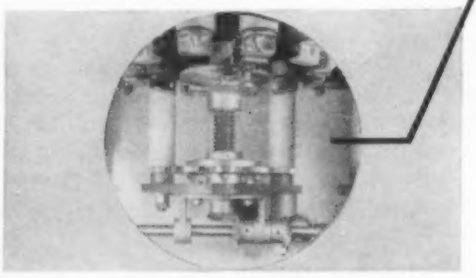
This new mechanical pressure-relief device relieves internal pressure at a predetermined setting by temporarily breaking a gasket seal around the valve cover . . . then completely and automatically reseals itself so that the device is fully effective. There are no parts to replace . . . no resetting is needed . . . *no breathing takes place* after the release of pressure. This prevents the entrance of moisture and other contaminating elements.



Top view shows pressure-relief device in sealed position. Bottom view shows how cover is raised to permit release of pressure, after which device automatically reseals itself.

2 EASY-TO-INSPECT TAP CHANGER

Pennsylvania's motor-driven tap changer is housed in separate compartments mounted on the transformer tank. This reduces down-time by greatly facilitating periodic inspection and maintenance. The mechanism includes a provision for emergency hand operation.

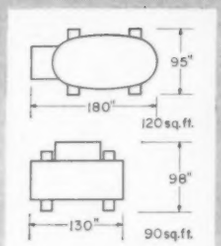


View through handhole in tap-changer compartment demonstrates ease-of-inspection feature.

Pennsylvania introduces

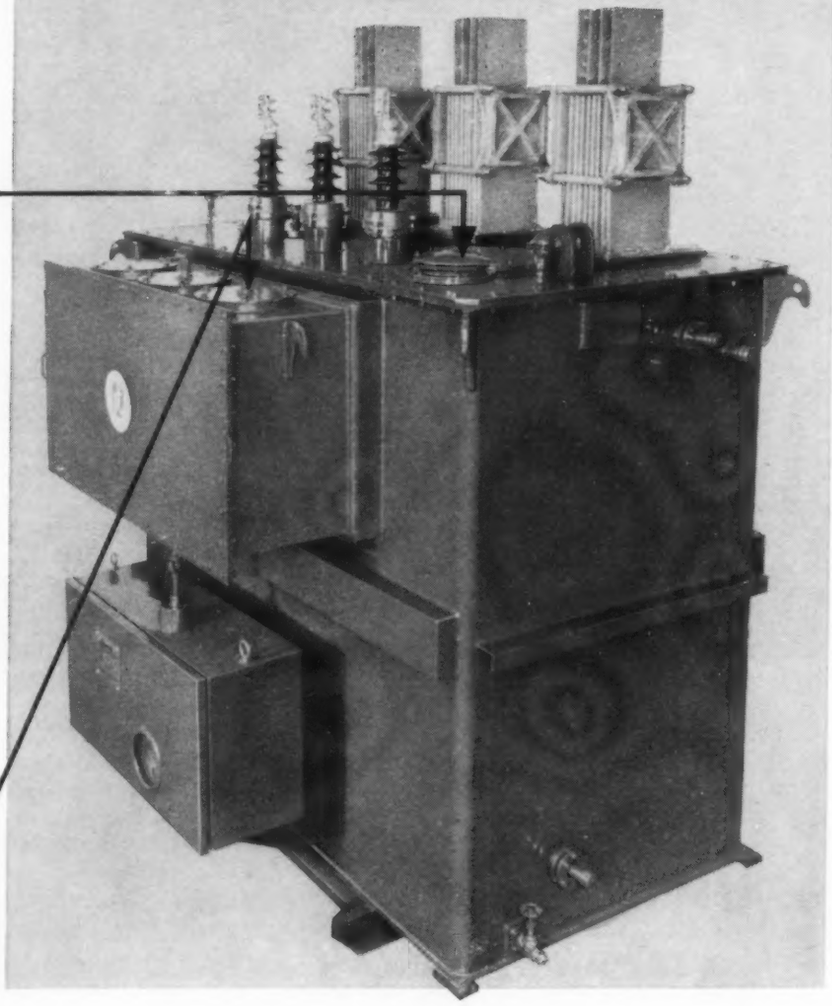
SPACE-SAVING RECTANGULAR TANK...

equipped with 2 outstanding time-saving features



25% less floor space

Required for Typical 7500-Kva Transformer



Pennsylvania has designed and built virtually every size and type of furnace transformer now in use: from 250 through 25,000 kva, and from 3175 through 82,000 amperes. To put this furnace transformer experience to work for you, contact Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pa.

PENNSYLVANIA FURNACE TRANSFORMERS

THE VENEZUELAN STEEL WORKS

by Dr. M. Gonni
Manager,
Engineering and Construction Div.,
Innocenti S. G.
Milano, Italy

Some of its unusual features are electric reduction furnaces instead of blast furnaces, a permanent pier designed for 13 m (42.5 ft) changes in water level, and tubular structures for some mill buildings.

THE consumption of steel products in Venezuela (mostly seamless tubes, reinforcing rods, structurals and merchant bars) has soared during these last years from almost insignificant values up to about 700,000 metric tons (775,000 net tons) per year. This market demand and the availability of iron ore, coal and electric power have been the reasons for the establishment of the Venezuelan Steel Works. Its present capacity is about 750,000 tons (825,000 net tons) per year of steel ingots. Future capacity is planned up to 1,500,000 tons (1,650,000 net tons) per year.

The Venezuelan authority in charge of this project is the Instituto Venezolano del Hierro y del Acero.

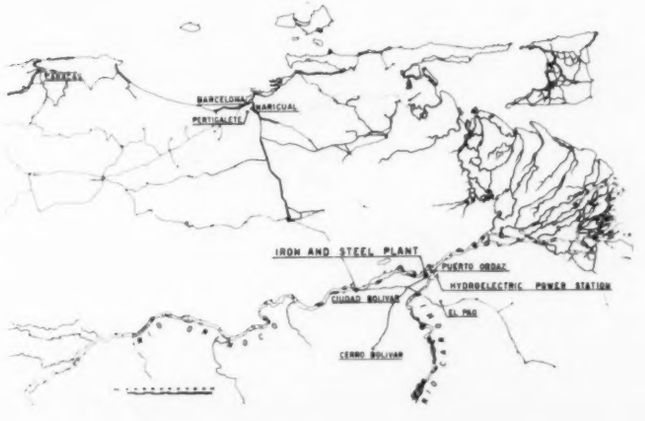
The project has some unusual features. Pig iron is made with low shaft electric reduction furnaces instead of conventional blast furnaces; this installation will be the largest of this type ever built. A permanent pier on the Orinoco River near the works site is designed in such a way as to accommodate the level changes of the river ranging up to 13 m (42.7 ft) between high and low waters. The supporting structures for some light buildings (seamless pipe mill, warehouses, wire drawing plant, iron foundry) are of tubular design.

The Venezuelan steel plant is also a striking example of international co-operation. Firstly, in this project there is a major participation of the Italian industry in the fabrication of the large structural steel buildings and in the manufacture of mechanical and electrical equipment as well as the other main facilities. Then there is the broad participation of American industry. U. S. manufacturers will furnish a 44-in. blooming mill, electric equipment (drives and controls), the open hearths, soaking pits and heavy crane engineering. The operating technique of the U. S. steel industry is present in the general conception of some fundamental departments of the works.

There is also the participation of some outstanding European concerns.

The civil engineering works are being carried out by Venezuelean and Italo-Venezuelan sub-contractors.

Figure 1 — The plant is located on the Orinoco River in Venezuela.



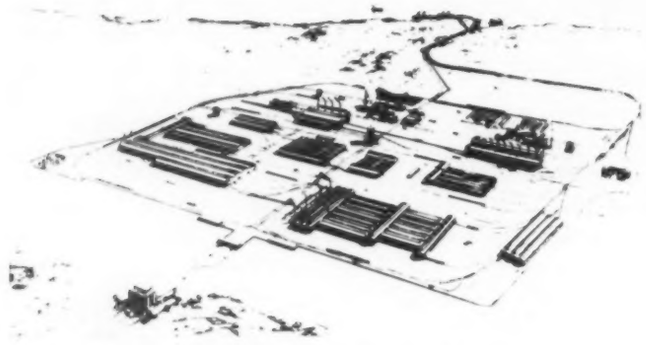


Figure 2 — Plant occupies about ¾ sq miles.

Before describing the project a brief outline of the raw materials to be used and of the processes selected to make pig iron and steel will be given.

MAJOR IRON AND STEELMAKING MATERIALS

Iron ore—In Venezuela several deposits of iron ore have been found. Involved in the operation of the plant are two mines: Cerro Bolivar in concession to U. S. Steel Corp. and El Pao to Bethlehem Steel Co. The ore from the first mine will be used for hot metal making, the one from the second mine will be used as addition oxide in the open hearth furnaces. Both of these ores are hematites very rich in iron content as seen from these percentage analyses:

	Cerro Bolivar	El Pao
Fe	58.00 to 61.50	61.55 to 65.00
SiO_2	0.45 to 1.43	1.43 to 1.00
P	0.105 to 0.04	0.077 to 0.05
Mn	0.02 to 0.04	0.08
S	0.019 to 0.041	0.043
Al_2O_3	0.74 to 1.92	4.68 to 2.00
I. L.	5.00 to 7.28	2.00
H_2O	5.08 to 9.33	1.00 to 5.98

Coal—The Venezuelan authorities intended to use their own coal coming from the mine of Naricual (near Barcelona) which they are now equipping from operation. It is a recent bituminous coal with a high content of volatile matter. Properly processed it may give a coke suitable for electric reduction furnace operation but not for blast furnaces.

Power—The required power will come from a large hydroelectric plant (initially equipped with four 70,000-kva groups) which will exploit the Caronì River through a huge dam. In September, 1958, this project was now at an advanced stage of realization.

Limestone—Limestone comes from Pertigalate quarry. It contains 54 per cent of CaO and practically no MgO.

HOT METAL AND STEEL MANUFACTURING PROCESS

The quality of the coal which does not allow for the making of blast furnace coke, the wide availability of low cost electric power, the high Fe content of the ore and the desire to exploit domestic raw materials have led the Venezuelan authorities to select electric furnaces for the ore smelting process.

As for the steel, when the layout of the plant was established, preference was given to the open hearth process for the present first stage of the plant. The alternative of an oxygen converter plant has been taken into consideration for future enlargements, which will consist mainly of facilities for manufacturing flat rolled products.

SELECTION OF THE PLANT SITE

The plant is located on the right bank of the Orinoco River at about 250 km (155 miles) from the sea and at a distance from Caracas of about 500 km (311 miles). The selection of this site, Figure 1, made by the Venezuelan Government, was determined by several factors:

1. Vicinity of the iron ore mines.
2. Wide availability of hydroelectric power and vicinity of the Caronì power plant (about 10 miles).
3. Navigability of the Orinoco River for high tonnage vessels. In fact, supply of the raw materials as well as transportation of the finished products can be done through this waterway.
4. A government policy in regard to the development of the country south of the Orinoco River. In particular, a residential area for 25,000 to 30,000 inhabitants will be developed in the vicinity of the plant.

THE PLANT

The plant site, Figure 2, is a rectangular area of about 2 km x 1 km (1.24 x 0.621 miles) at 45, 40 m (149 ft) above the minimum level of the river.

There will be on the Orinoco an autonomous pier for unloading raw materials (iron ore, coal, limestone) subsequently transported to the storage yards along belt conveyors. The finished products, on railway cars and trucks, will be transported to the pier for shipping to the points of consumption.

Production program—The breakdown of the rolled steel program is given below:

	Metric tons per year	Net tons per year
Reinforcing rod and wire rod	125,000	138,000
Medium and small sections	60,000	66,100
Structurals and railway materials	20,000	22,100
Rails	50,000	55,100
Seamless steel tubes	295,000	325,000
Total finished products	550,000	606,300

To the aforesaid products should be added those of an iron foundry:

Ingot Molds and stools	About 20,000	22,000
Spun iron pipes	About 30,000	33,100

and those of a wire drawing plant:

Black annealed wire, galvanized wire, barbed wire and nails (the corresponding wire-rod is included in the above mentioned breakdown for the rolled products)	About 27,000	29,800

General arrangement of the plant—As may be seen from the plan, Figure 3, along a first alinement there are the stockyards for ore, limestone and coal. Along a second alinement there are the sintering plant and coke oven plant.

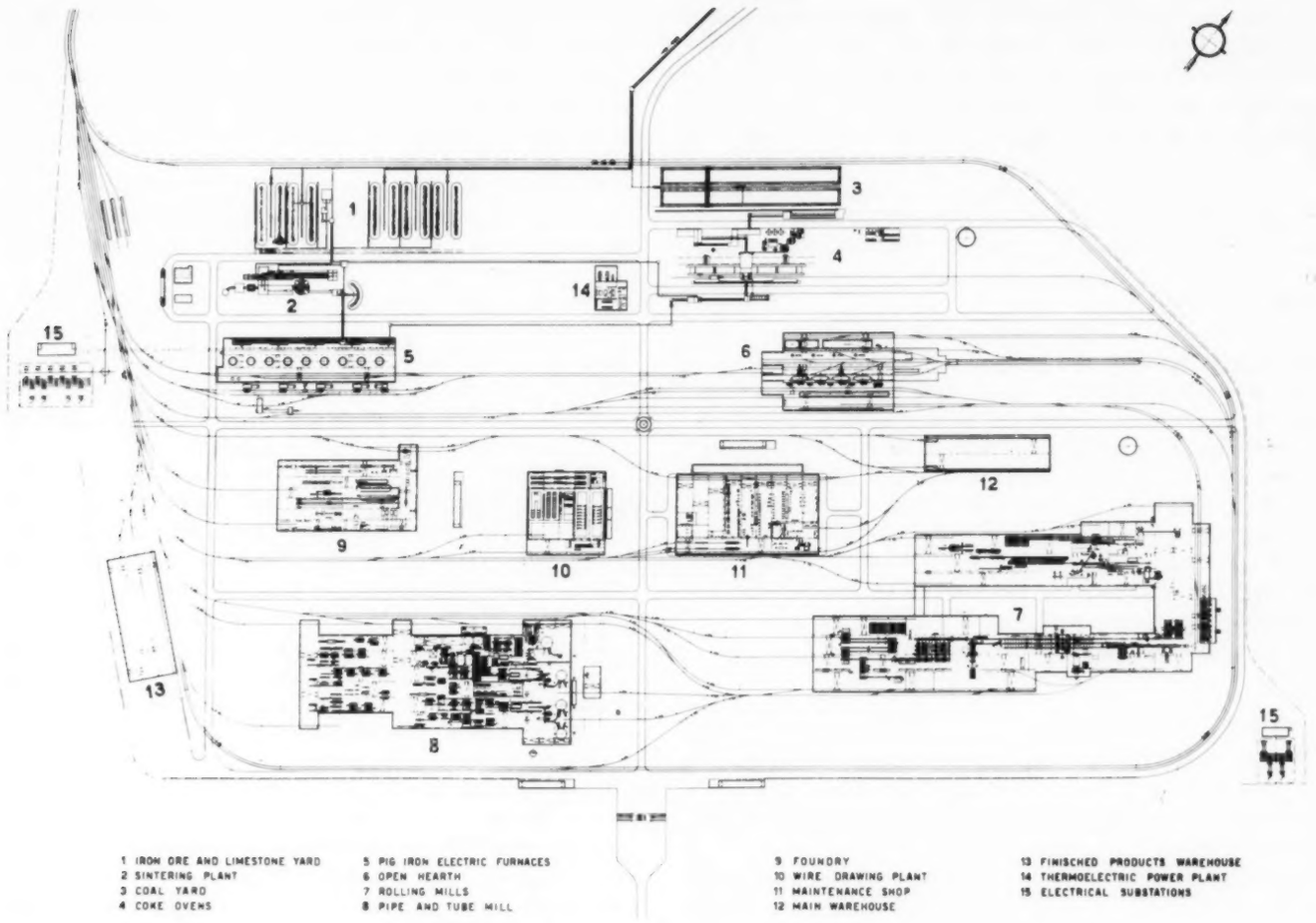
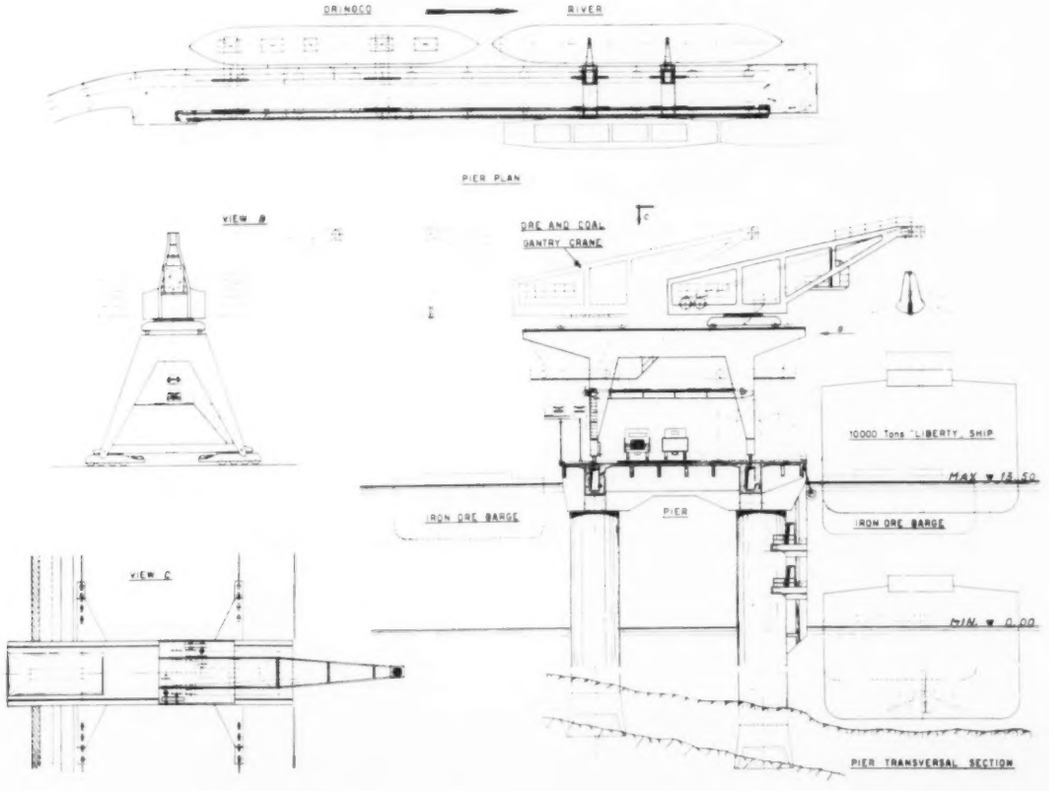


Figure 3 — General arrangement of the plant provides for future expansion.

Figure 4—The plant's pier on the Orinoco is large enough to dock two 10,000-ton freighters at the same time along the side toward the center of the river.



Iron ore, sinter, limestone and coke are converted by belts to the electric reduction furnaces.

Electric furnaces, steel shop, rolling mills and the seamless tube mill are arranged along a continuous flow line that in a rectangular plan takes the shape of a "U."

The flow of materials (liquid pig iron, ingot steel, rolled products, tubes) is one-way throughout without any backward motion; this in particular was made possible by the soaking pits—blooming mill arrangement at a right angle.

Within the "U" flow line, where expansions of the operating departments are not contemplated, the general warehouse for spare parts, the maintenance shop, the wire drawing plant, the iron foundry and other service departments are located. The finished product warehouse is located outside the flow-line of the plant so that the shipping operations are independent of the inner plant traffic.

Outside the plant area there are also two electric receiving substations at 115,000 volts for the electric reduction furnaces and for the other services. This location is for safety reasons.

MAIN DEPARTMENTS

Pier on the Orinoco River—On the Orinoco erection was underway in September, 1958, of a large reinforced concrete pier, Figure 4, for loading and unloading. Located parallel to the river bank, it is 25 m (84.2 ft) wide and about 300 m (687 ft) long. Its connection with the bank is through an ample curved reinforced concrete accessway. The big columns are built with compressed air caissons, and the beams are cast on the spot.

The river level between the rain season (May to October) and the dry season (November to April) has a difference of 13 m (42.6 ft); thus the pier, in order to permit the docking of vessels at any level, had to be designed quite high.

It is possible to dock two 10,000-ton freighters at the same time along the pier side toward the center of the river, pius one barge along the bank side even during low water periods.

The iron ore, railway borne from the Cerro Bolivar mine to Puerto Ordaz, is loaded into barges which are pushed by towboats along the river for some 15 km (9.35 miles) up to the pier. However, the possibility of receiving the iron ore through a direct track connection with the aforesaid railway is foreseen.

The pier is equipped with two 22-ton (24 net ton) unloading gantry cranes. Their average unloading capacity is 380 to 400 tons (420 to 400 net tons) per hour each, referred to the iron ore (capacity under favorable conditions is 500 to 550 (550-605 net) tons per hour). With regard to limestone and coal, however, the above values drop to 200 to 250 (220–275 net) and 140 to 180 (155 to 200 net) tons respectively. The two belt conveyors from the pier to the plant are built for the capacity of 1100 (1200 net) tons per hour each (referred to iron ore). On the pier there are also three 10-ton (11 net) loading cranes for the finished products.

For the plant operation a small fleet is also necessary: five to six 8000 to 10,000-ton freighters for coal and limestone, the same number of 3000-ton freighters for transporting the finished products, and one tug and one barge for the iron ore.

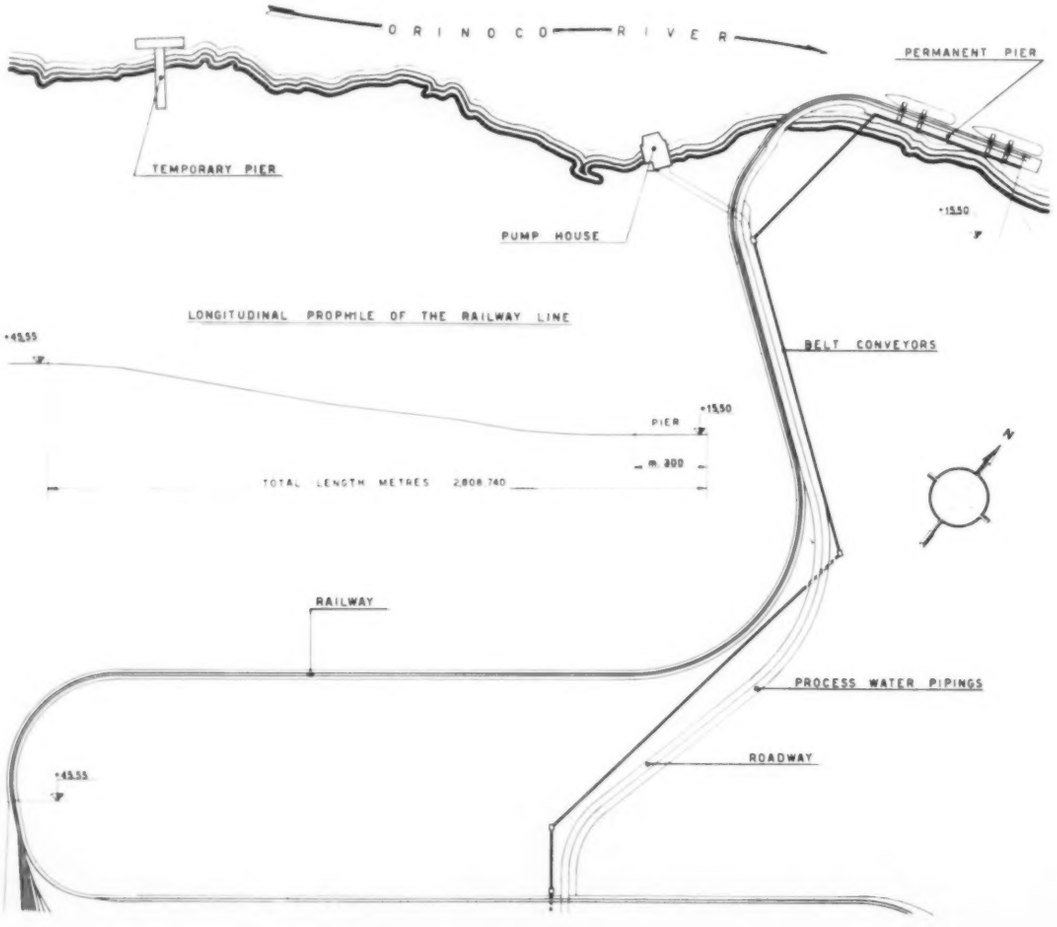
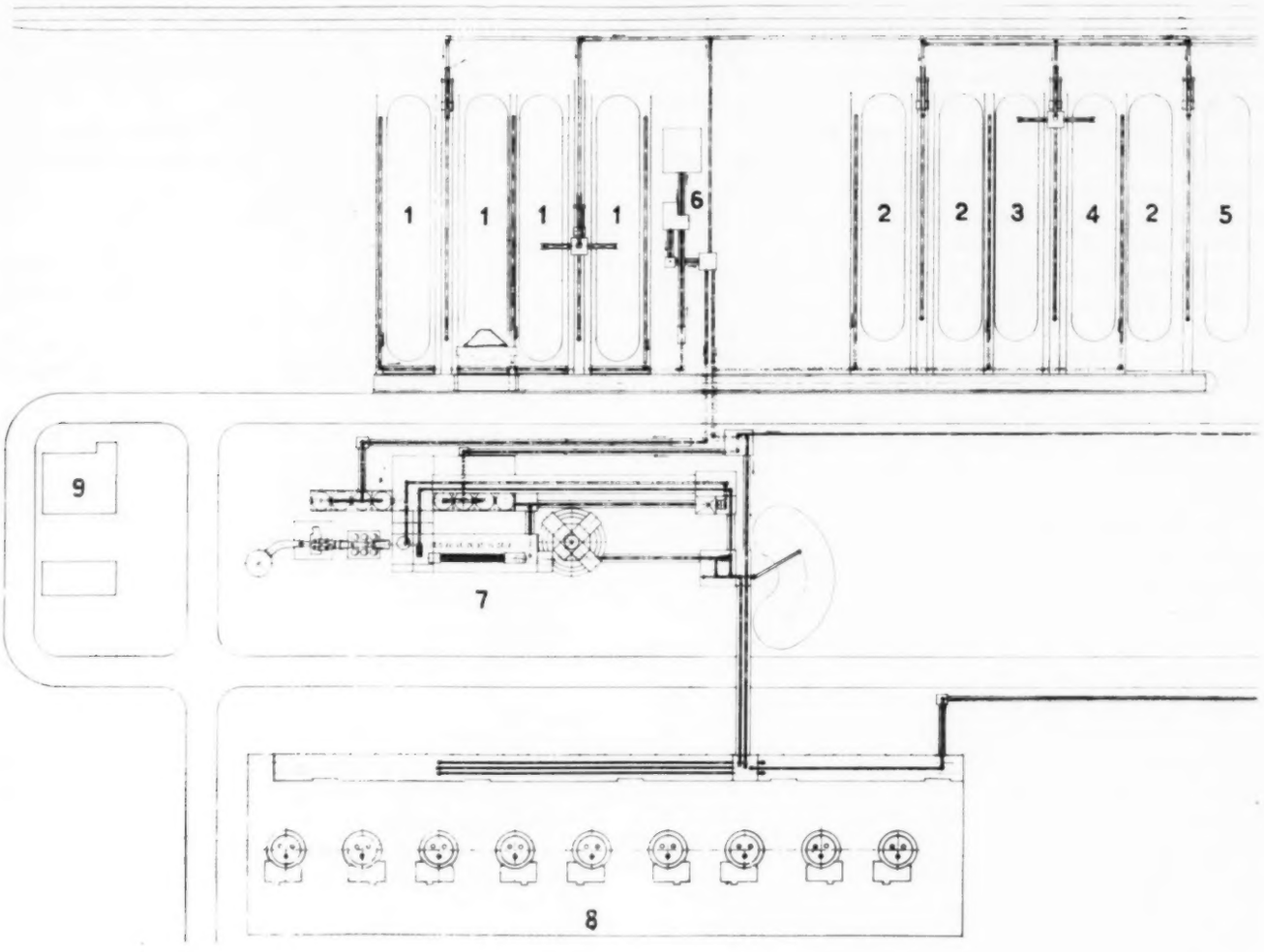


Figure 5 — A belt conveyor system transports ore, limestone and coal from the pier to the storage yards.



1 CERRO BOLIVAR IRON ORE
2 LIMESTONE
3 DOLOMITE
4 SILICEOUS SAND
5 EL PAO IRON ORE
6 IRON ORE SCREENING AND DRYING PLANT
7 SINTERING PLANT
8 PIG IRON ELECTRIC FURNACES
9 ELECTRODE PASTE PLANT

Figure 6 — Ore and limestone storage yards and sintering plant are fed by belt conveyors.

Belt conveyors—A belt conveyor system, Figure 5, runs right along the pier; from the root of the pier it heads to the plant site arriving at a switching station in the yard area. From here one conveyor, at the right side, feeds the ore and limestone yards and another conveyor, at the left side, feeds the coal yard.

Iron ore and limestone storage yards—Though in September, 1958, only one type of iron ore was available, the ore storage, Figure 6, and reclaiming was done with a traveling-belt conveyor and stacker blending system adapted to the peculiar requirements of the plant. The considerations which led to this choice are the following:

1. Ore, during the rain season (lasting four to five months), absorbs a lot of water. The belt reclaiming machine is much more efficient than the conventional grab bucket system. In fact, while the latter during its grabbing tends to press the ore making more difficult the subsequent operations of handling and screening, the belt machine, working on the transversal section of the ore storage pile, sends loose material to the subsequent operations.

2. The ore yard is located on a back-filled area. The conventional equipment of the ore bridge, besides requiring piling, thick foundation slabs, etc., might cause movements of the ground owing to the unevenness of height of the ore storage piles. It was decided to avoid this.

3. Ore, though coming from the same mine, presents variations in composition and screen analysis. From the sintering tests carried out for this purpose, it also showed differences in behavior among the various samples tested. That is why the homogenization of the ore is always recommendable. Moreover, it is likely that in the future other ores may be used.

The operating cycle is the following: the ore, arriving from Puerto Ordaz already crushed down to a maximum size of 5 in., is stored through a system of conveyors and a stacker in two oblong storage piles as it arrives from the pier and at the same rate of unloading from the barges. There are a couple of piles being formed, another couple being reclaimed. Each storage pile contains about 15,000 (116,500 net) tons; in total 4 x 15,000 = 60,000 tons (66,000 net tons) can be stored. Considering the mine vicinity, this amount is held sufficient for the plant operation.

Ore, after reclaiming by the belt machine, is conveyed to a crushing and screening plant which crushes the

size above 3 in. and then separates the two sizes of −8 mm (−5/16 in.) and of 8 to 75 mm (5/16 to 3 in.).

When the ore has absorbed a great deal of water, as happens during the rain season, the screening operation is extremely difficult (at least according to information coming from steel plants utilizing Cerro Bolivar ore). Then provision has been made for three rotating dryers through which the wet ore passes before going to the screening station.

The two sizes of ore (−8 mm (−5/16 m) and 8 to 75 mm) (5/16 in. and 5/16 to 3 in.) coming out of the screening station are conveyed to the sintering plant and to the electric reduction furnaces respectively.

The other raw materials, limestone, dolomite, silica and El Pao iron ore (in large lumps for the steel shop), are stocked with the same system (however without homogenization) and reclaimed with mechanical shovels.

The transportation to the steel shop of limestone and El Pao ore is done by trucks; the handling of limestone, dolomite and silica to the sinter plant and the electric furnaces are done through belt conveyors.

Ferroalloys will be carried from the pier to the plant with railroad bin cars which empty into proper trenches. From here ferroalloys will be stocked and then removed with movable cranes.

Sinter plant—The size of iron ore which will be used directly in the electric reduction furnaces, is 8 to 75 (5/16 in. to 3 in.) mm (which represents about 35 per cent of the total amount). The remaining 65 per cent of fines having a size under 8 mm (5/16 in.) will be sintered. For this purpose a large sinter machine is installed. The sinter produced will be dry-cooled on a rotating cooler.

The raw materials are handled through a belt conveyor system to a battery of 12 bins: six of these are for the ore fines, two for the coke breeze and the others for limestone, sand and mill scale.

The raw materials are fed from these bins by proportioning feeders to conveyor belts for transporting the proper mixture to a primary rotating drum which pre-mixes the feed materials with the return fines [−8 mm (−5/16 in.) size]. The mix is then passed to a secondary rotating drum and is then fed to the sintering machine.

At the discharge end the sinter is screened; the fines, [−8 mm (−5/16 in.) size], whose amount is expected to be around 50 per cent of the total, are recirculated. After cooling, a portion of the 8 to 20-mm (5/16 to 25/32 in.) size is also recirculated to form the hearth bed [with a proposed thickness of some 6 cm (1.52 in.) for protecting the grate bars].

Self-fluxing sinter will be produced to improve the smelting process in the electric furnaces.

A set of cyclones for dust separation is interposed on the collecting main ahead of the exhauster.

The sinter having a size above 8 mm (5/16 in. is taken by belt conveyors to the electric furnace storage bins.

Coke oven plant—The study of this subject was still under way in September, 1958. Our exposition is limited to some points already fixed, taken from a preliminary report on the coal and on the coke plant made by Dr. Ferrara of Vetrocoke S.p.A., Torino (Italy).

In the Naricual mine several seams have been found. From the viewpoint of the coal used, the tested qualities may be grouped in two categories: agglomerating and nonagglomerating.

Some samples, taken from two seams (which have been envisaged for the future program of exploitation) showed the following analysis:

	Per cent (dry basis)
First seam (agglomerating)	
Ashes	4.60
Volatile matter	43.70
Fixed carbon	51.70
Gross heating value	7,885,000 cal

	Per cent (dry basis)
Second seam (non-agglomerating)	
Ashes	4.27
Volatile matter	42.00
Fixed carbon	52.73
Gross heating value	7,800,000 cal

The blends of the two qualities, which have been envisaged as probable for the oven charge, are 50 to 50 or 1/3 to 2/3. Both produced coke suitable for electric reduction furnaces. The first blend—more probable—produced coke with a yield of 60 per cent (of which 55 per cent in lump size to be employed in the electric furnaces and 5 per cent fines for the sintering) and 350 Nm^3 per ton (11,200 cu ft per net ton) of coke oven gas at a net heating value of 4800 cal per Nm^3 (136 cal per cu ft or 540 Btu per cu ft).

For obtaining a coke mixture, first of all the two coal qualities shall be stored individually so that they may be blended in the needed proportions; then the agglomerating properties of the mixture shall be emphasized by increasing the charge density and adding other possible materials. In any case a long stay in the yards is to be avoided to prevent oxidation of the stored coals.

The foregoing samples of Naricual coal show considerable similarities to certain coals of the Lorraine field where the problems have been since long solved on an industrial scale.

The preliminary studies would have led to a conventional by-product coke oven battery with pre-compressed charge (pilonnage). This type of ovens would give the maximum possible flexibility, allowing also the use of blends with high grade coking coals.

The coke plant will be completed by coal storage with central stock stacker, equipment for the charge preparation, coke screening station, recovery of coal chemicals limited initially to tar and ammonium sulphate, and gas exhausters, electrical services, etc.

The whole handling system, from the coal storage to the coke transportation to the electric furnaces, is done through belt conveyors.

A joint technical committee consisting of representatives of the Venezuelan authorities, of the mine management and of the engineers will soon re-examine the whole problem which, from the Venezuelan side, will be extended to the mine proper.

Meanwhile, some facilities were being provided

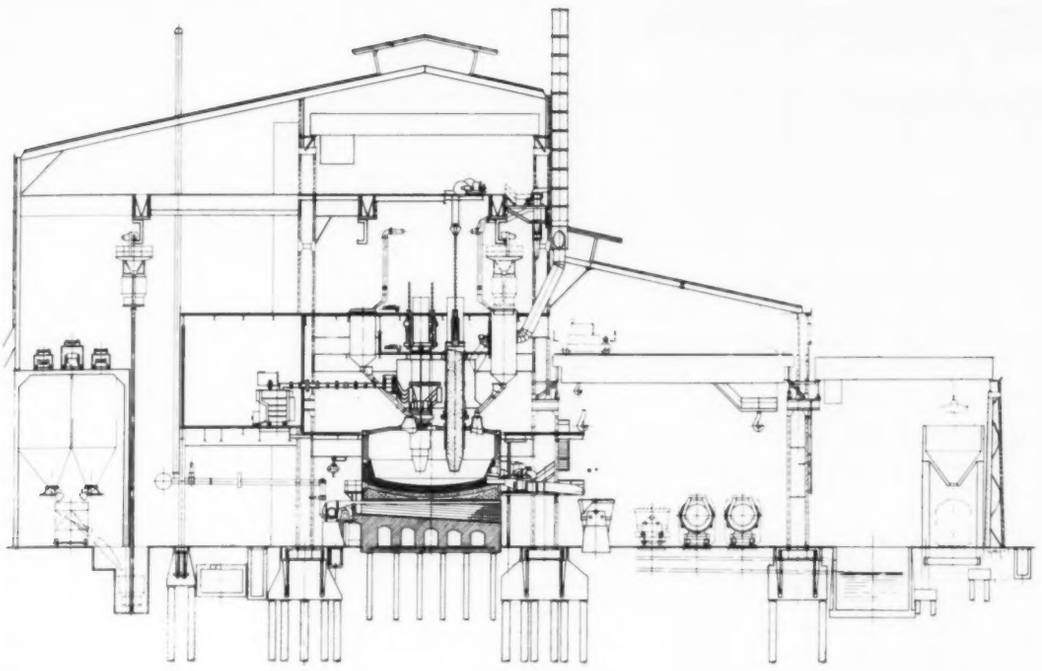


Figure 7 — Nine Tysland Hole type electric reduction furnaces will produce hot metal for the steelmaking facilities.

in September, 1958, for starting the plant operation with imported coke.

Electric reduction furnaces—This is the biggest installation in the world of electric reduction furnaces of the Thysland Hole type, consisting of mine units, rated at 33,000-kva each and with an estimated single production capacity of 200 to 220 tons per day of pig iron.

The furnaces, Figures 7 and 8, are of the low shaft type; three self-baking continuous electrodes, having a diameter of 1.5 m (4.91 ft), pass through the roof of each furnace. The hearth is made up of rammed dolomite with underlying layers of magnesite brick. The side wall lining is made up of fireclay brick material. The inner diameter of the shell is 11.5 m (37.8 ft). The height from the hearth line to the roof skewback is about 5 m (16.4 ft).

Each furnace is fed by a transformer of 33,000 kva stepping down the voltage from 22,000 volts to the furnace operating voltages ranging from 240 to 170 volts in 18 taps; the hourly electric average load is about 20,000 kw. A 15,600-kva capacitor battery raises the line power factor up to 0.9.

The furnaces and their services are installed in a structural steel building 290 m (951 ft) long and 71 m (233 ft) wide; the area under the roof is 20,500 sq m (215,000 sq ft). The weight of the structural building is about 11,000 tons (12,100 net tons).

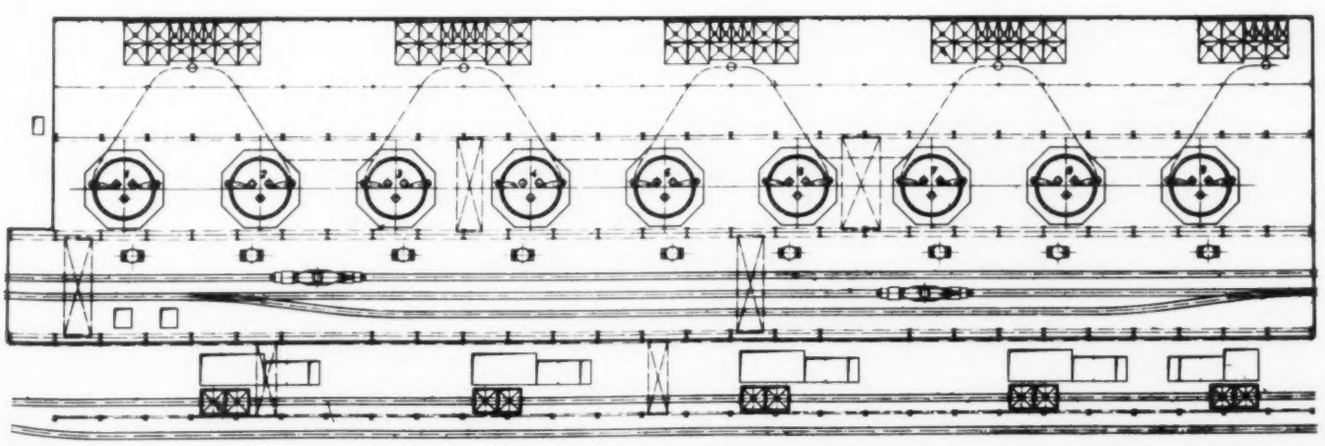
There are five sets of stock bins for the raw materials, one for every two furnaces; each set has a capacity of 2000 cu m (70,500 cu ft) and is equipped with a scalecar and monorail grab for hoisting the materials and dumping them into the nine feeding bins of each furnace, the nine bins having a total capacity of 180 cu m (6,350 cu ft). From these bins the charge is fed by gravity through charging chutes to the furnace shafts. Each monorail can perform 12 runs per hour, that is about twice as much as necessary.

In the furnace bay are two 7.5-metric ton overhead traveling cranes and a 40-metric ton one for the furnace maintenance. In the tapping bay are two 120/40-metric ton d-c overhead cranes.

The hot metal, which is tapped every four to five hours into ladles, is poured from these into mixer type hot metal cars by which it is transferred to the steel shop.

For making one ton of hot metal the following ma-

Figure 8 — Plan for the electric reduction furnaces.



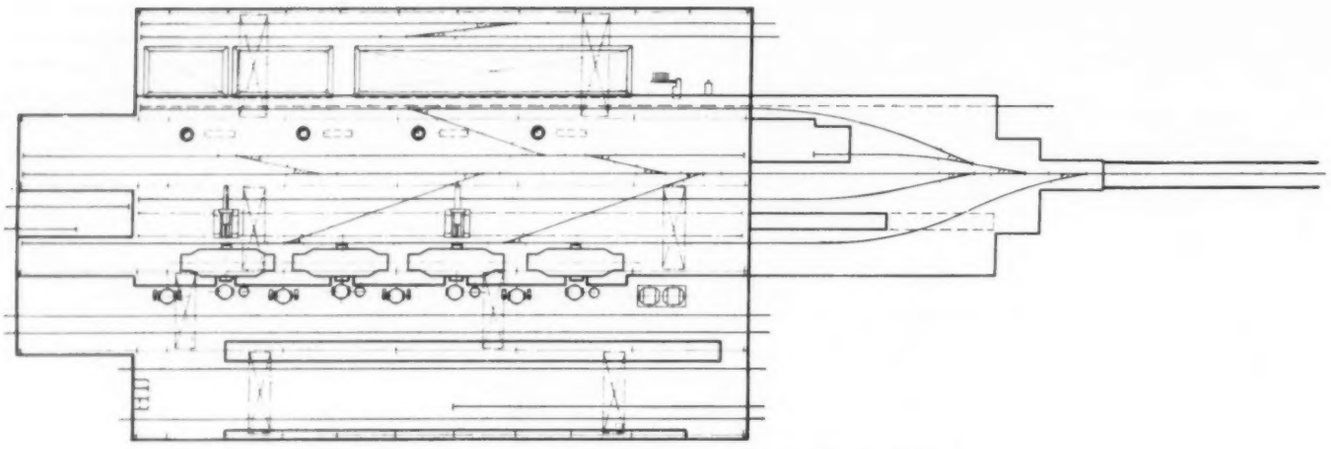


Figure 9 — The meltshop has four 250-ton open hearths.

terials are required:

Iron ore	about 1600 Kg (3540 lb)
Coke	about 400 Kg (880 lb)
Limestone	about 235 Kg (517 lb)
Silica	about 85 Kg (188 lb)
Electric power	2300 to 2400 kwhr

As for the size, sinter and ore must be in the range of 8 to 75 mm ($\frac{5}{16}$ to 3 in.); coke is fed separately in the two sizes of 6 to 25 ($\frac{1}{4}$ to 1.0 in.) and 25 to 50 mm (1.0 to 2.0 in.) in order better to control the porosity and the electric resistance of the burden.

Electrode paste is manufactured in a nearby plant rated at 8000 metric tons per year.

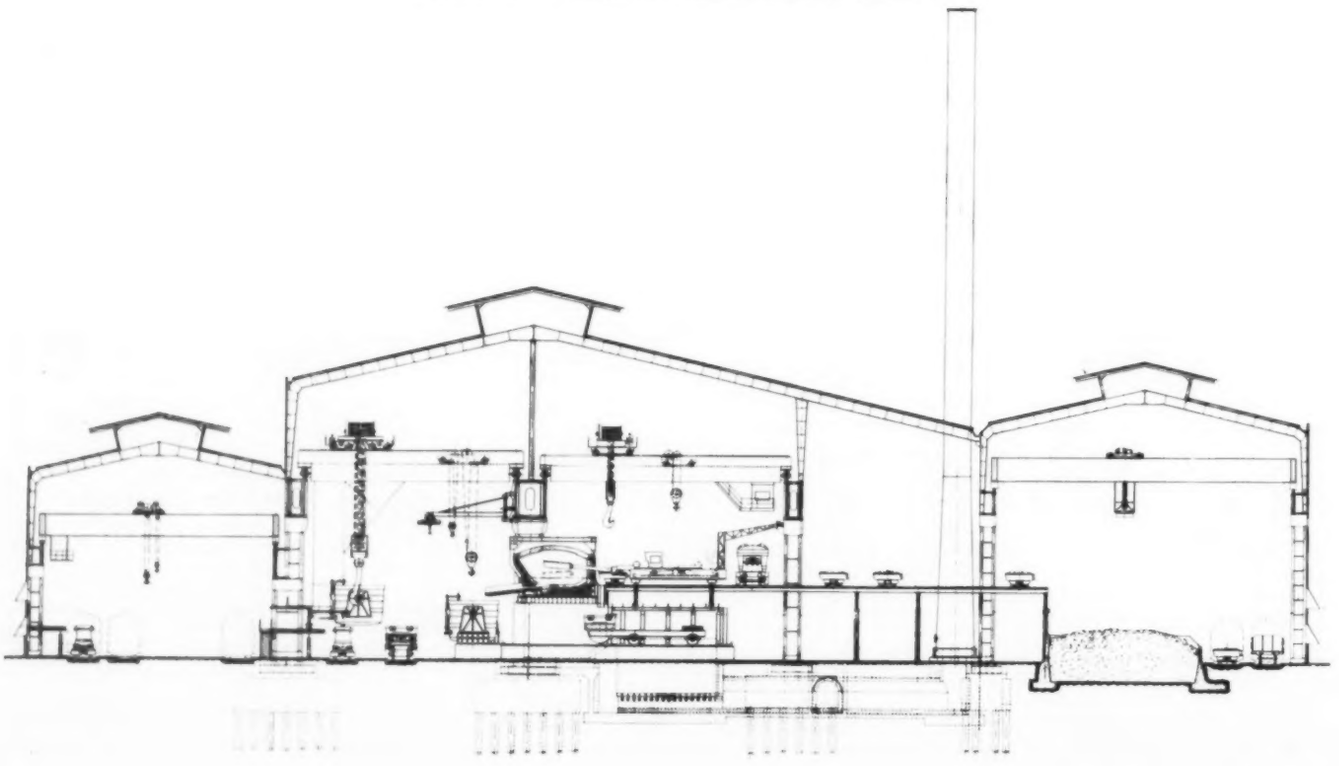
Slag is granulated under water pressure in a completely conventional installation located outside the furnace building and serviced by two 10-ton traveling cranes. It consists of one granulation basin and a set of bins for every two furnaces.

Adjacent to the furnace building there is a 2-chain pig casting machine rated at 2500 tons per day. Should it be necessary, the hot metal produced daily may all be poured into the pig machine.

Steel shop—Figures 9, 10 and 11 show an open hearth shop equipped with four 250-ton (275 net ton) furnaces. The building, crosswise, is divided into five bays: scrap and raw material stockyard, lean-to, furnace bay, pouring bay, mold yard. The total area of the building is 25,000 sq m (269,000 sq ft). The spacing of the furnaces, center to center, is 34 m (111 ft). Lengthwise the building is divided into seven sections: one for ladle repair, four for the furnaces, one as a bracing section of the building structures and one for lifting the hot metal onto the charging floor.

After the fourth furnace, between the sixth and seventh column, there is in the building structure a 8.5-m (27.9 ft) span strongly braced which acts as the fixed point of the whole building in relation to thermal

Figure 10 — Transverse section of the meltshop.



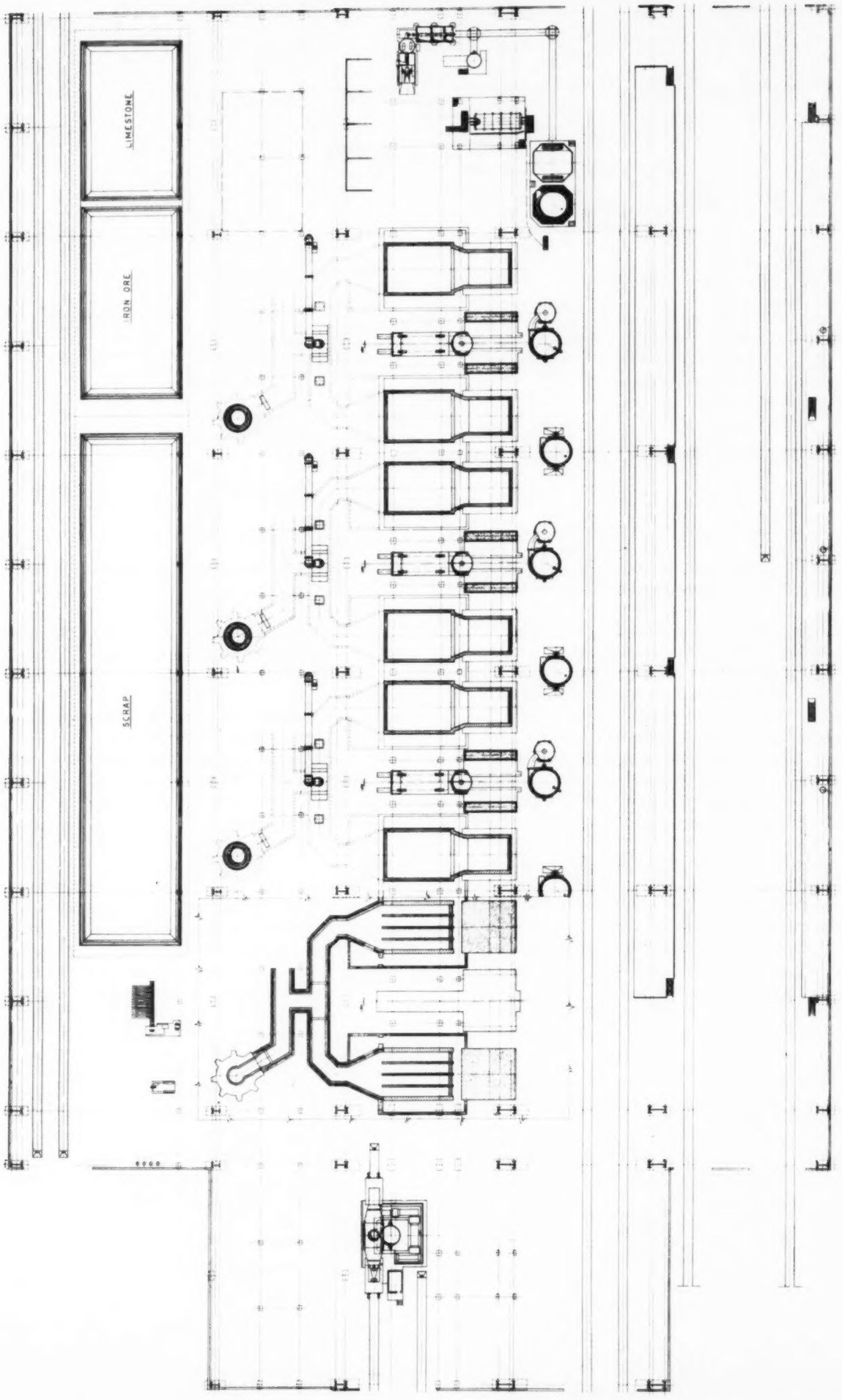


Figure 11 — Ground floor plan of the meltshop.

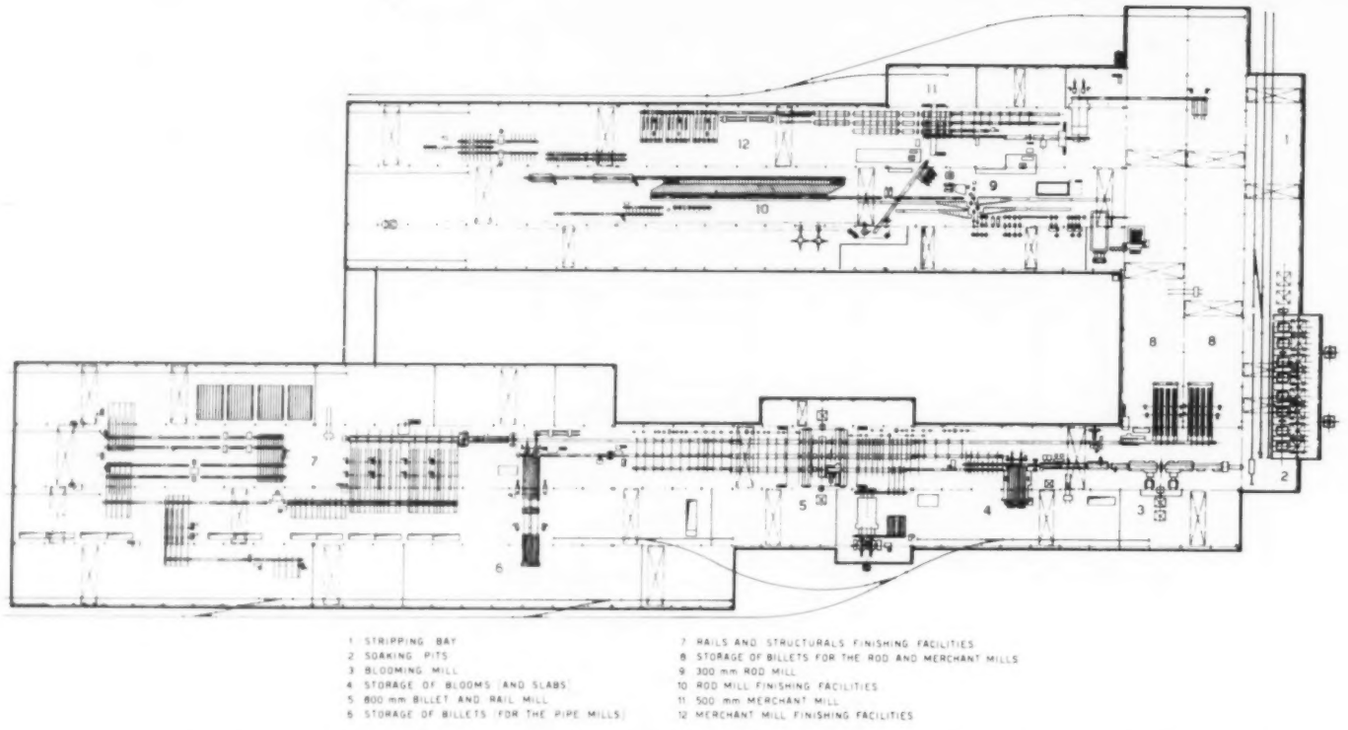

1 STRIPPING BAY
2 SOAKING PITS
3 BLOOMING MILL
4 STORAGE OF BLOOMS (AND SLABS)
5 800 mm BILLET AND RAIL MILL
6 STORAGE OF BILLETS (FOR THE PIPE MILLS)
7 RAILS AND STRUCTURALS FINISHING FACILITIES
8 STORAGE OF BILLETS FOR THE ROD AND MERCHANT MILLS
9 300 mm ROD MILL
10 ROD MILL FINISHING FACILITIES
11 500 mm MERCHANT MILL
12 MERCHANT MILL FINISHING FACILITIES

Figure 12 — In the rolling mill building, the stripping and pit furnace bay is perpendicular to the blooming mill bay and the rod and merchant mill, and section mill bays.

expansion. The eventual set of new furnaces will be arranged symmetrically to the present one.

From the mixer type car (which is spotted on the ground floor) the hot metal is poured into the transfer ladle (placed in the bottom of a pit) and thence lifted to the charging floor by the hot metal cranes.

The main lifting facilities are two 390/60/20 metric ton ladle cranes, two 160/40 metric ton hot metal cranes, two 10 metric ton charging machines, two 25 metric ton mold yard cranes and two 15 metric ton stockyard cranes.

The open hearth furnaces, rated at 250 metric tons (275 net tons), can actually tap almost 300 metric tons (330 net tons). Bath area is 97 sq m (1040 sq ft); bath depth is 670 mm (26.3 in.)

The main roof and the two port roofs of each furnace are fully basic and suspended. The uptakes are basic too. The two regenerative chambers have a cross section of 9705 x 7050 mm (31.8 x 23.1 ft) and a checker height of 5520 mm (18 ft); their roof is flat, suspended and built of fireclay bricks.

The furnaces are fired with cold coke-oven gas for 60 to 70 per cent and fuel-oil or tar for the balance, or with 100 per cent oil.

For each furnace there will be a set of instruments and controls and a waste heat boiler at 30 kg per sq cm (420 psi) and 350 C (662 F) with an expected steam output of six to seven tons per hour.

The steels to be made are mainly of the following type: A 00, Aq 34, Aq 42, Aq 50 (Italian specifications) for structurals, shapes, rod, wire rod; steel for rails; and GB–J 55, N 80 (API specifications) for pipes.

Owing to scarcity of scrap in Venezuela, for the steelmaking process a quite high percentage of molten pig iron is to be charged. However, as a compensation for this high hot metal charge, there is its quite low silicon content due to the low silica content in the ore.

The open hearth is provided with its own servicing facilities (fuel oil distribution system, gas boosters, ladle heating and repair, oven for drying the ladle stoppers).

Access to the charging floor is through a ramp having a 2.5 per cent slope ending at the head of the open hearth building in a wide track shunting platform in reinforced concrete structure. The area covered by this platform is utilized as warehouse for refractory material. The purchased scrap is stored in the open air, its cutting and preparation take place in the roofed storage bay. The charging boxes may be filled at the ground floor and brought to the charging floor through the ramp, or may be directly filled at the charging floor.

An oxygen plant supplies oxygen for bath decarburization, scrap cutting and other uses.

Rolling mills—The general layout is shown on Figure 12. The stripping and pit furnace bay is perpendicular to the blooming mill bay and to the rod and merchant mill and section mill bays. Billets for these two mills are cooled and stored in two bays parallel and adjacent to the stripping bay. The whole building covers an area of about 110,000 sq m (1,180,000 sq ft).

Stripping—The stripping and pit furnace bay is 27.40 m (90 ft) wide. The stripping zone is about 100 m (328 ft) long and is provided with three tracks. There are two stripper cranes for big-end-down and big-end-up ingots (hoisting capacity 30, metric tons (33 net tons) stripping 300 tons). There is sufficient room to store about 7000 (7700 net) tons of cold ingots.

The ingot dimensions are:

7.5 metric ton normal type	760 x 760 x 1900 mm (29.9 x 29.9 x 74.8 in.)
5.5 metric ton rail type	690 x 690 x 1830 mm (27.2 x 27.2 x 72.0 in.)
9.5 metric ton slab type	670 x 1150 x 1950 mm (26.4 x 45.2 x 76.7 in.)

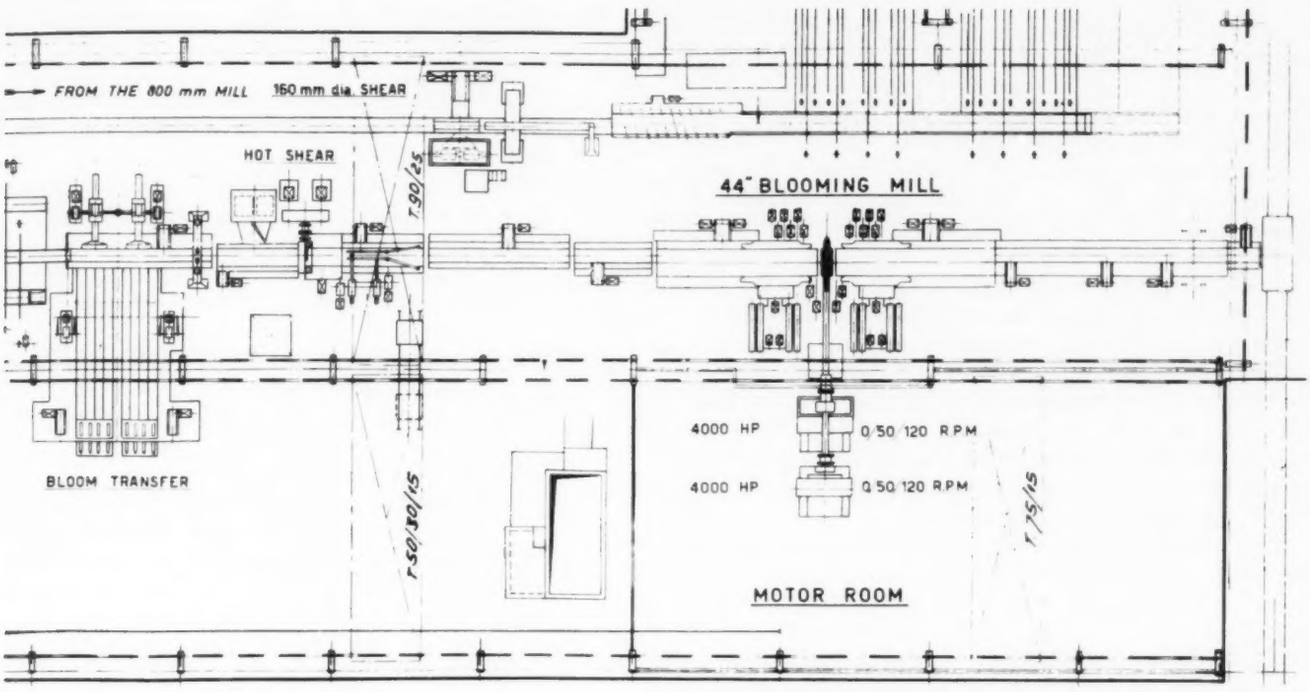


Figure 13 — The 44-in. blooming mill has a fast drive with moderate torque because it essentially produces blooms and billets.

Pit furnaces—There are eight one-way fired 125-ton soaking pit furnaces with refractory recuperators for the preheating of the combustion air. There are natural draught stacks, each one connected to four pits. The pit dimensions are 4500 x 6000 x 4000 mm (14.8 x 19.7 x 13.1 ft). They are fired either with electric furnace gase or fuel oil; maximum firing rate 23.8 x 10^6 Btu per hour per pit.

The normal control and regulation instruments (fuel-air ratio, furnace pressure, furnace temperature) are provided.

Heating time is comtemplated as follows: 4 to 5 hours for hot charge (2 to 3 hours track time) and 10 to 12 hours for cold charge.

There are two 15 metric ton (16.5 net ten) pit cranes for charigng and discharging the pit furnaces. Foundations for two additional pits are under way.

Blooming mill—The blooming mill equipment, Figure 13, mainly consists of:

An ingot buggy side dumping the ingot into a receiving table.
An approach roller table, 23 m (75.5 ft) long, line shaft driven, and divided in three sections, table width 1320 mm (52 in.).
Two line shaft driven mill tables on the front and on the rear of the stand, about 13.85 m (45.5 ft) long [roller diameter 458 mm (15 in.), roller length 2700 mm (8.85 ft)].
Besides the two feed rollers the first six rollers on each side are individually driven (this arrangement avoids the mill tables working in the first passes of the ingots).
Stand:
- Roll diameter . . . . . 1100 mm (43.2 in.)
- Body length . . . . . 2800 mm (110 in.)
- Lift . . . . . 1320 mm (51.9 in.)
- Counterweight balanced top roll

Manipulators: double manipulator with tilting fingers on both sides.
A delivery table 7.30 m (23.9 ft) long.
A shear approach table [about 25 m (82 ft) long].
Motor driven shear for cutting slabs 1060 x 152 mm (41.7 x 6.07 in.) and blooms 305 x 305 mm (12 x 12 in.) max.
A transfer for slabs and blooms 9 m (29.5 ft) wide.
Two slab and bloom pushers and pilers.
Drive:
Twin drive with two 4000-hp d-c motors, 700 volt, 0/50/120-rpm.
Motor-generator set:
One 6000-hp synchronous motor, 13.8 kv, 60 cycles. 185,000 hp-sec flywheel.
Two 3500-kw, 700 volt d-c generator.
Maximum working torque: 260 ton-meters (1,700,000 (lb-ft) (2.25 x normal torque).
Emergency torque: 315 ton-meters (2,060,000 lb-ft) (2.75 x normal torque).
Screwdown speed: 250 mm per sec (9.82 in. per sec).
Reversal time from +50 rpm to −50 rpm: 1.5 sec.

This blooming mill essentially produces blooms and billets; therefore a fast drive with a moderate torque has been chosen. However, it can normally produce slabs 1060 mm (41.8 in.) wide and 152 mm (6.09 in.) thick and exceptionally 1170 x 203-mm (46.1 x 8.0 in.) slabs.

Rolling time anticipated for forming a 200 x 200-mm (7.8 x 7.8 in.) billet from a 7.5 metric ton (8.25 net ton) ingot is approximately 80 sec in 17 passes. The average output of the blooming mill is conservatively estimated at 1,200,000 metric tons (1,320,000 net tons) per year [200 metric tons (220 net tons) per hour x 6000 hours], but this figure will certainly be exceeded in operation.

All the auxiliary drives are provided with d-c motors, mill type; screwdowns, mill roller table, manipulators and shear are driven at variable voltage; the other

roller tables and services are driven at 230-volt constant voltage.

800-mm (31.4 in.) 2-high reversing mill—This is a 3-stand reversing mill with 800-mm (31.4 in.) diameter, 2200-mm (86.5 in.) body length rolls. Stand No. 1 has screwdown and manipulator on the entry side. Turning devices are installed on the front and on the rear of stands No. 2 and 3. A transfer connects the delivery end of the blooming mill roller table and the entry ends of stands No. 1 and 2 roller tables. This transfer can be extended in the future outside of the bay for feeding a continuous billet mill.

The main drive consists of two 6400-hp, 80/180-rpm d-c motors. These motors are fed by a motor-generator set with one 7500-hp, 13.8-kv, 60-cycle synchronous motor and four 2500-kw, 700-volt, d-c generators.

The drive motors are located one at the side of stand No. 1; the other at the side of stand No. 3.

The rolling mill can work with two stands driven by one motor and with the other stand driven by the other motor so as to roll at the first two stands at a certain speed and make the final passes on the third stand at higher speed.

Normally this mill rolls billets and blooms, as they are delivered by the blooming mill without reheating However, a 50 metric ton (55-net ton) per hour continuous reheating furnace allows also operation of the 800-mm (31.4 in.) mill independently from the blooming mill.

All drives subjected to many reversals (screwdowns, manipulators, roller tables on the front and on the rear of the stand) are fed by d-c motors, mill type, variable voltage. The other drives (approaching and delivery roller tables, transfer, etc.) are fed by a-c motors.

The rolling program of this mill is essentially the following:

For about 250,000 metric tons (275,000 net tons) per year it rolls 125 x 125-mm (4.91 x 4.91 in.) to 275 x 275-mm (10.8 x 10.8 in.) billets for tubes (a part of the tubes is rolled directly from ingots and blooms).

For about 200,000 metric tons (220,000 net tons) per year it rolls 80 x 80-mm (3.14 x 3.14 in.) billets for the rod and merchant mill and 160 x 160-mm (6.28 x 6.28 in.) billets for the medium section mill.

For about 70,000 metric tons (77,000 net tons) per year the mill rolls 100 lb per yard rails and heavy sections, angles from 120 to 200-mm (4.71 to 7.86 in.), channels from 140 to 300 mm (5.5 to 11.8 in.), "I"-beams from 180 to 300 mm (7.09 to 11.8 in.).

For each of these three types of products the rolling mill has an independent delivery arrangement with its own cutting and finishing facilities.

Tube billets are delivered on the rear of stand No. 2, billets for the 500-mm (19.6 in.) mill and the rod and merchant mill are delivered on the front of stand No. 3, rails and heavy sections are delivered on the rear of stand No. 3.

Finished rails will be 12 m (39.4 ft) long. They can be made in accordance with European standards. For American type rails, pits for the controlled cooling are provided.

300-mm (11.8 in.) rod and merchant mill—The mill mainly consists of:

a. One 45 (50 net ton) ton per hour heating furnace for 80 x 80-mm (3.14 x 3.14 in.) billets, 6 m (19.3 ft) of maximum length;
b. Six roughing stands whose motors are driven by a 1500-kw transformer-rectifier set:
   1. Stands No. 1 and 2: roll diameter 450 mm (17.6 in.) roll body length 900 mm (35.4 in.), 700-hp, 350/875-rpm, d-c drive motor.
   2. Stands No. 3 and 4: roll diameter 380 mm (14.9 in.), roll body length 900 mm (35.4 in.), 700-hp., 350/875-rpm, d-c drive motor.
   3. Stands No. 5 and 6: roll diameter 380 mm (14.9 in.), roll body length 900 mm (35.4 in.), 700-hp, 350/875-rpm, d-c drive motor.
c. Six intermediate stands, each driven by a 700-hp, 350/875-rpm, d-c drive motor. These motors are fed by a 3000-hp transformer-rectifier set:
   1. Stands No. 7 and 8: roll diameter 380 mm (14.9 in.) roll body length 900 mm (35.4 in.).
   2. Stands No. 9, 10, 11 and 12: roll diameter 300 mm (11.8 in.), roll body length 700 mm (27.5 in.).
d. Four finishing open stands, each driven by an 800-hp, 350/875-rpm, d-c motor, roll diameter 300 mm (11.8 in.), roll body length 600 mm (23.6 in.).
e. Six finishing tandem stands, roll diameter 250 mm (9.83 in.)., roll body length 500 mm (19.6 in.) driven by a 1500-hp, 300/650-rpm, d-c motor.

The motors of group (d) and group (e) are fed by one 3000-kw transformer-rectifier set.

The production of this rolling mill is mainly:
Wire rod of 5.38 mm (0.211 in.) diam.
Concrete reinforcing bars from 6 to 30-mm (0.23 to 1.10 in.) diam.
"T," channels and angles from 20 to 40 mm (0.78 to 1.58 in.).

Rounds from 10 to 30 mm (0.39 to 1.18 in.) and sections are finished at the four finishing open stands. The last of them is connected to the cooling bed by a roller table on which two flying shears are installed. Finishing equipment is installed such as straighteners, cold shear for cutting at length, and pilers.

Wire rod and rounds up to 8 mm (0.314 in.) are instead finished at the following six finishing tandem stands and are wound up in coils by four reels. The wire rod is delivered at 20 m per sec (3950 fpm) speed. A hook conveyor transfers the coils to the storage.

500-mm (19.6 in.) 3-high mill—This is a conventional mili consisting of:

a. One 25-ton per hour heating furnace for 160 x 160-mm (6.3 x 6.3 in.) billets of 2.50 m (98.5 in.) length.
b. One 3-high roughing mill with 650-mm (25.5 in.) diam and 1800-mm (70.7 in.) length rolls, followed by a hot shear to cut sections up to

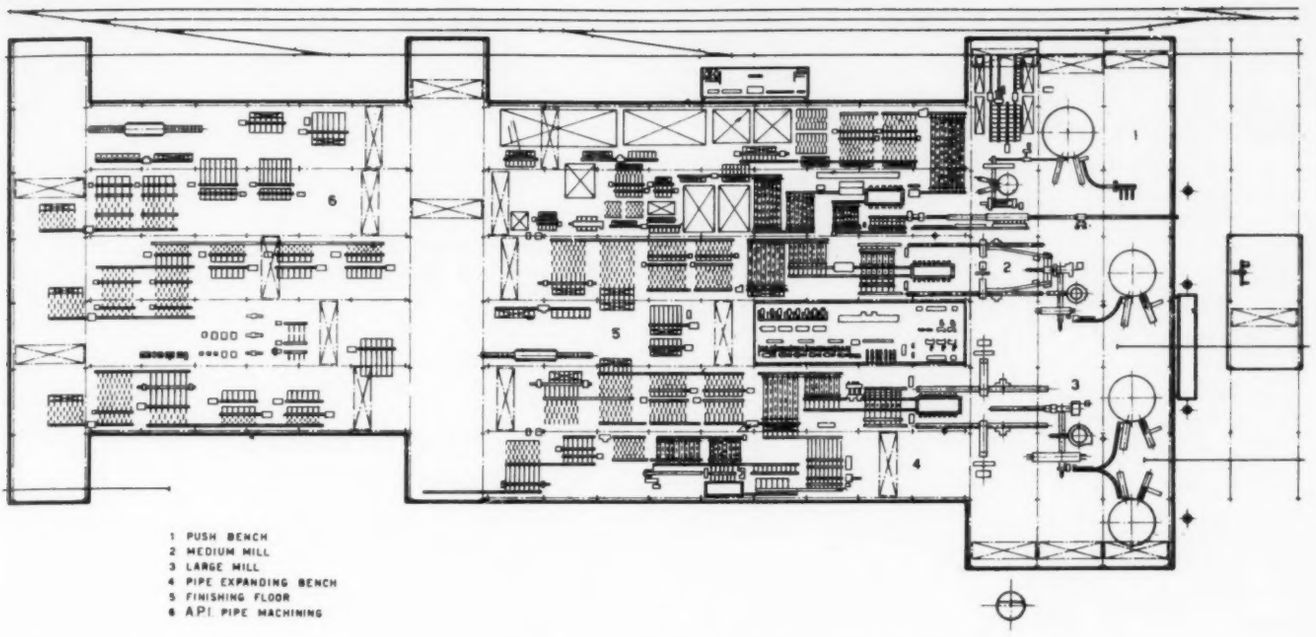


Figure 14 — The seamless pipe mill will be able to handle as much as 295,000 tons per year.

160 x 160 mm (6.3 x 6.3 in.). The mill is driven by a 1500-hp, 710-rpm, a-c motor.

c. Three 3-high finishing stands with 500-mm (19.6 in.) diam and 1600-mm (62.8 in.) length rolls for the first two stands and with 500-mm (19.6 in.) diam and 1250-mm (52.9 in.) length rolls for the third stand. These stands are driven through a reducing gear by a 3000-hp, 250/500-rpm d-c motor and are fed by a transformer-rectifier set. Mill speed can vary between 100 and 200 rpm.

On the delivery side of each stand there is a tilting table; on the delivery side of the third stand three hot saws are installed followed by three hot beds. Finishing equipment consists of two roller straighteners, a press and a cold shear.

The mill produces mainly angles from 50 to 100 mm (1.96 to 3.93 in.), channels from 65 to 120 mm (2.55 to 4.71 in.) and "I" beams from 80 to 160 mm (3.15 to 6.29 in.).

Type of sections—Nowadays rolled materials imported in Venezuela come from the U.S.A.; however, our proposal to adopt UNI standards has been accepted, pending the Coal and Steel Community unification.

Seamless steel pipe mill—It is planned to manufacture about as much as 295,000 metric tons (325,000 net tons) per year of seamless steel pipes and tubes from ½ to 24 in. diam through the following facilities, Figure 14:

a. One push bench for tubes from ½ to 5½ in. Estimated capacity 100,000 metric tons (110,000 net tons) per year.
b. One medium 2-stand pilger mill for tubes from 2⅜ to 7 in. Estimated capacity 60,000 tons per year.
c. One large 2-stand pilger mill for tubes from 6⅝ to 16 in. Estimated capacity 135,000 tons per year.
d. Hot tube expanding equipment to expand tubes made at the large pilger mill, up to 24 in. diam.

Push bench—This is fed with 127 to 178-mm (5 to 7 in.) billets. Hourly output 25 metric tons (27.5 net tons). Maximum number of pieces: 200 per hour.

The push bench consists of the following parts:

One rotary hearth furnace for heating billets, rated at 25 metric tons (27.5 net tons) per hour, served by an automatic charging and discharging machine.

One roller type sizing machine.

One 400-ton horizontal piercing press to convert the sized billets into bottles with the inside of the bottom ogive shaped.

One small rotary hearth furnace for intermediate reheating, served by an automatic charging and discharging machine, from which the bottles are transferred to the elongator.

One elongator mill which also equalizes the wall thickness of the bottles. It is powered by a 1200-kw d-c motor. From this mill hollow blooms with solid bottom are obtained.

One push bench for tubes up to 5½ in. diam. Maximum speed of the working stroke: 4.5 m per sec (14.7 ft per sec); constant return speed: 5 m per sec. (16.3 ft per sec). Complete set of mandrels from 68 to 133-m (2.66 to 5.22 in.) diam; maximum tube length: 12 m (39.4 ft).

The push bench is powered by two reversible, double wound motors, for a total power of 2500 kw fed by an adjustable voltage set driven by a synchronous motor.

The tubes obtained at the push bench are brought up again to hot working temperature in a walking beam furnace, the hearth of which is 14 x 3.6 (46 x 11.8 ft).

Starting from the discharge end of the furnace, the flow line divides into two separate branches designed to work alternately according to the size of the tubes obtained from the push bench.

The first branch includes an 18-stand stretch reducing mill to produce tubes from 2 to ½ in., each stand consisting of two rolls. The reducing mill is driven by eight 120-hp d-c motors having a wide range of speed such

as to allow a wide range of tube stretching. The motors are fed by a special converter set and have an automatic speed control. The second branch consists of a 7-stand sizing mill to size tubes from 5, ½ to 2 in., driven by a 200-kw variable speed d-c motor.

From the hot mills the hot rolled tubes are delivered to the cold finishing floor including straightening machines, cutting-off machines, automatic threading machines for API and standard pipes.

Medium mill—Rolls billets from 178 to 254 mm (5.84 to 8.37 in.), as well as 279-mm (9.17 in.) blooms. Output 25 metric tons (27.5 net tons) per hour. Maximum number of pieces 60 per hour.

The line starts with a rotary hearth furnace for heating billets, rated at 25 metric tons (27.5 net tons) per hour, served by two pinch type charging and discharging machines. The discharging is automatic.

The billets at rolling temperature are converted into bottles on an 800 metric ton (880 net ton) piercing press from which, after an intermediate reheating in a rotary hearth furnace, the bottles are fed to an elongator mill which also equalizes the wall thickness and opens completely their bottoms thus giving completely hollow blooms. The elongator mill is driven by a 1600-kw, d-c motor.

After leaving the elongator mill the hollows are delivered to the pilger mill stands, which are two and work in parallel alternately for manufacturing tubes from 7 to 2⅜ in.

The two pilger mill stands are driven by a single 80 to 175-rpm, 1500-kw, d-c motor placed in a central position. The hollow bloom is fed to the pilger mill by two feeders operated by 180-atmosphere hydraulic pressure.

The pipes obtained are brought up again to hot working temperature in a walking beam furnace with 15.5 x 3.8-m (0.861 x 0.149 in.) hearth and fed into a 9-stand sizing mill driven by a 200-kw, d-c motor. The sizing mill manufactures tubes from 7 to 2⅜ in.

From the hot working section the tubes are delivered to the cold finishing floor including one straightener machine, end machining equipment, hydraulic testing and final inspection. The finishing floor is specially equipped for pipes to be used in the oil industry.

Large mill—Rolls blooms from 279 to 330 mm (9.17 to 10.8 in.) and corrugated round ingots having 475 to 530 mm (15.6 to 20.8 in.) diam. Maximum output is 50 metric tons (55 net tons) per hour. Maximum number of pieces is 40 per hour.

The mill is equipped with two 25-metric ton (27.5 net ton) each rotary hearth furnaces served by charging and discharging machines. The blooms or ingots are pierced on a 1200-metric ton (1320 net ton) press. The operating cycle is then similar to that of the medium mill and the machines are the following:

An elongator mill driven by a 1800-kw d-c motor.

Two pilger mill stands working in parallel. Each stand is driven individually by a 35 to 90-rpm, 1600-kw, d-c motor. Both stands are provided with feeders operated by 180-atmosphere hydraulic pressure. The pilger mill produces tubes from 184 to 438 mm (7.23 to 17.2 in.) outside diameter.

A walking beam furnace with 15.5 x 5-m (51 x 16.4 ft) hearth.

A 5-stand sizing mill; three of these stands are driven by a 110-kw, d-c motor each. This mill manufactures tubes from 16 to 7 in.

Cold finishing floor similar to that of the medium mill.

Hot tube expanding equipment—Starts from the hot rolled pipes produced in either pilger stand of the large mill. Maximum output 25 metric tons (27.5 net tons) per hour. Maximum number of pieces 12 per hour. A furnace is provided for heating one end of the pipe, which is then expanded and bell-shaped on a 450 to 700-metric ton (495 to 770 net tons) press. Then the end expanded pipes are heated throughout their length in a furnace having 15 x 6-m (49.2 x 19.7 ft) hearth.

The tubes are next conveyed to the hot expander draw bench, and the bell shaped end is spray-cooled and held firmly. By making proper bars—having expander plugs fitted on—to be drawn through the pipe, by the end of the operation the pipes can be expanded to diameters up to 24 in. outside diameter.

The expanding machine has a power of 100 metric tons (110 net tons) and is driven by a 600-kw, d-c motor fed by an adjustable voltage generator set.

This line also includes a cold finishing floor for tube end machining and hydrostatic testing facilities.

Wire drawing plant—The wire drawing plant, Figure 15, is fed by wire rod rolled at the semi-continuous wire rod mill. Its yearly production program is the following:

	Metric tons	Net tons
Black annealed wire	8,800	9,670
Galvanized wire	2,150	2,360
Barbed wire	14,850	16,300
Nails	1,200	1,320
Total	27,000	29,650

The plant is enclosed in a tubular structure building divided into several bays arranged in such a way as to allow a functional flow of the material in the course of processing.

The coiled rods storage and the pickling bath are located in the incoming material bay. From here the rod is handled to the draw bench (15 units).

After drawing, the wire that will only be annealed is sent to two annealing furnaces. The wire to be galvanized is sent to two 32-strand continuous hot dip galvanizing lines with continuous lead bath annealing equipment. For barbed wire production there is a set of 32 machines. The nail machines (12 units) are kept separate owing to their noisiness.

Within the building there is ample room for storing the incoming coiled rods and the wire products. Provision has been taken for extending the building for the eventual enlargement of the plant.

Iron foundry—The integrated plant includes a pig iron foundry, Figure 16, for making ingot molds and stools as well as spun iron pipes.

The above are the main products. However, there are also facilities for small miscellaneous iron casting, which may be needed for maintenance and other uses, as well as facilities for small bronze castings.

As metallurgical coke is not available in Venezuela, cupolas cannot be operated; and therefore the foundry

is fed with liquid charge which is processed and reheated in electric arc furnaces.

One ore reduction furnace is accordingly run for making foundry pig iron while the others make hot metal for the open hearth. As the production capacity of one 33,000-kva furnace is somewhat above the foundry needs, this pig iron excess is used in the open hearth charge either mixed with the hot metal from the other reduction furnaces or as cold pigs obtained at the pig casting machine. Also the rejected and scrapped ingot molds and stools are to be charged into the open hearths.

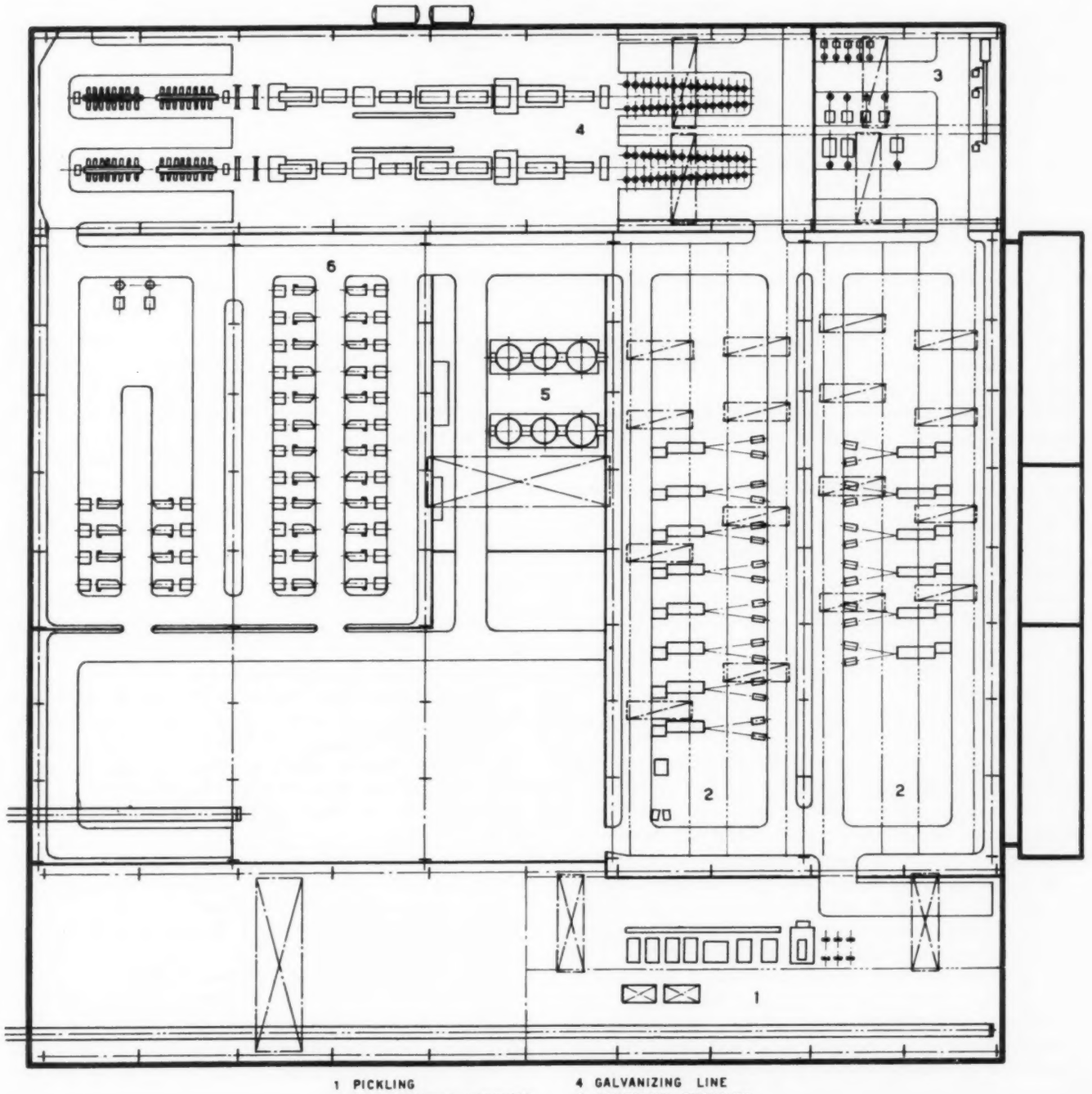
The foundry is enclosed in a building consisting of a transverse bay made up of structural steel framing and of several longitudinal bays in tubular steel framing. The total area is 26,000 sq m (280,000 sq ft) on a rectangle of 224 x 112 m (734 x 768 ft).

In the transverse bay there are the following facilities: molten pig iron arrival station, a 150-ton (165 net ton) mixer for the pig iron and the electric arc furnaces.

In one of the longitudinal bays, besides the centrifugal casting machines, the pipe finishing, testing and tar coating facilities are located. The iron pipe sizes produced will range from 50 to 150-mm (1.96 to 5.9 in.) diam, 2 m (6.55 ft) length, for civil engineering use (downspout, sewer and water drains), and from 50 to 400-mm (1.96 to 15.7 in.) diam and 3 to 4 m (9.83 to 13.1 ft) length for conduits.

In the other bays, the equipment is located for ingot

Figure 15 — Plan of wire drawing plant.



1 PICKLING
2 WIRE DRAWING MACHINES
3 NAIL MACHINES
4 GALVANIZING LINE
5 ANNEALING FURNACES
6 BARBED WIRE MACHINES

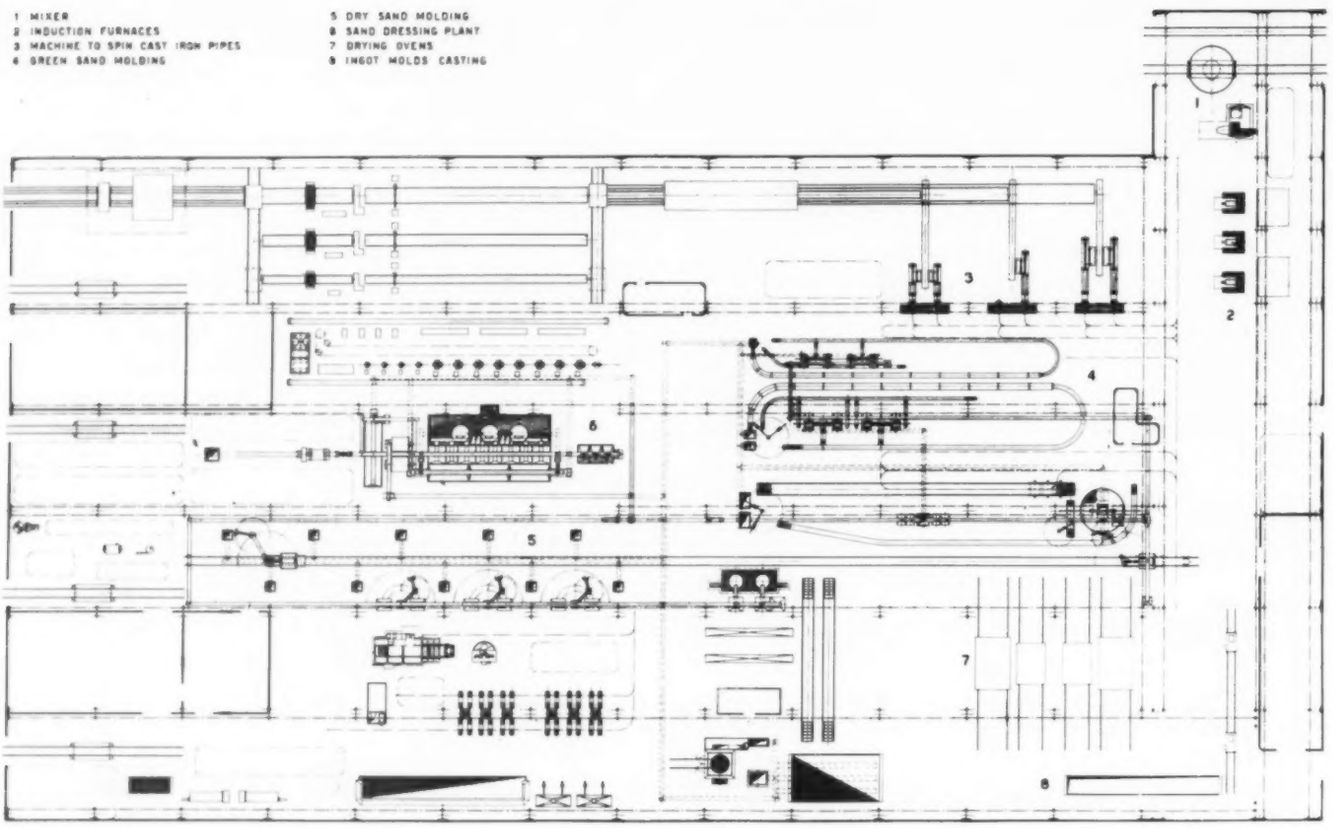


Figure 16 — The pig iron foundry makes ingot molds and stock as well as spun iron pipe.

mold and stool casting as well as for medium and small miscellaneous castings (core drying ovens, casting platform, etc.).

The foundry equipment is completed by a wholly mechanized sand dressing and handling plant.

BUILDING AND CIVIL ENGINEERING WORKS

Structures—roofs—siding—All the buildings are made of steel structures. Two leading ideas have been followed: for the light buildings (warehouses, mechanical shop, seamless pipe mill, wire drawing plant and foundry) tubular structures have been adopted; for the heavy buildings (reduction furnaces, open hearth, rolling mills) standard heavy structural framing has been adopted.

The roof deck is of aluminum sheets with glazing of transparent plastic sheets along the monitors.

The external cladding is aluminum sheeting with interposed transparent plastic sheet glazing. At the base there is a 2.20-m (7.1 ft) high wall of concrete blocks. Continuous openings all along the perimeter of each building provide for a good inside air circulation.

Owing to the plant location being in a tropical region, the aforesaid kind of highly reflecting roofing and cladding, better than any other material, insures comfortable living conditions inside the buildings.

Site conditions—foundation construction—drainage—To obtain a flat 2-km² (0.772 sq miles) area, over 6,000,000 cu m (7,850,000 cu yd) of soil have been moved. The site elevation of the plant is 45.40 m (149 ft); the amount of excavation above said elevation has more or less compensated the filling.

The soil has a top layer which was satisfactorily compact but immediately underneath, it was sandy, very soft and friable. Its bearing capacity could not be assumed above 0.5 kg per cm² (7.1 psi). Therefore, all the foundations required piles or wide reinforced concrete slabs.

Up to September, 1958, during soil tests and excavations, no underground water layer has been struck. During the execution of the pier foundations in the Orinoco very solid rock has been reached at only 4 to 5 m (13.1 to 16.4 ft) under the mud layer deposited on the river bottom.

The huge caisson enclosing the water intake and pumping station of the process water system is being sunk within the solid alluvial banks of which the river bottom is made up in that location.

Provision has been made for the construction of a huge drainage and sewer system for disposal of the process waters (cooling and other uses in the plant) as well as the heavy rainfalls which during the rainy season reach considerable amounts, 60 to 65 mm (2.35 to 2.55 in.) in one hour. The main culver is up to 2.5 m (8.2 ft) diam.

SERVICES

Also for the services, this discussion will indicate only the main characteristics.

Electrical distribution is shown in Figure 17.

Switch station—All the electricity for the works is supplied by the Caronì hydroelectric power plant through four overhead 115-kv lines to a switch station belonging to Electrificatiòn del Caronì. From this station four lines are run direct to feed the electric furnace receiving substation (R1), and two to another

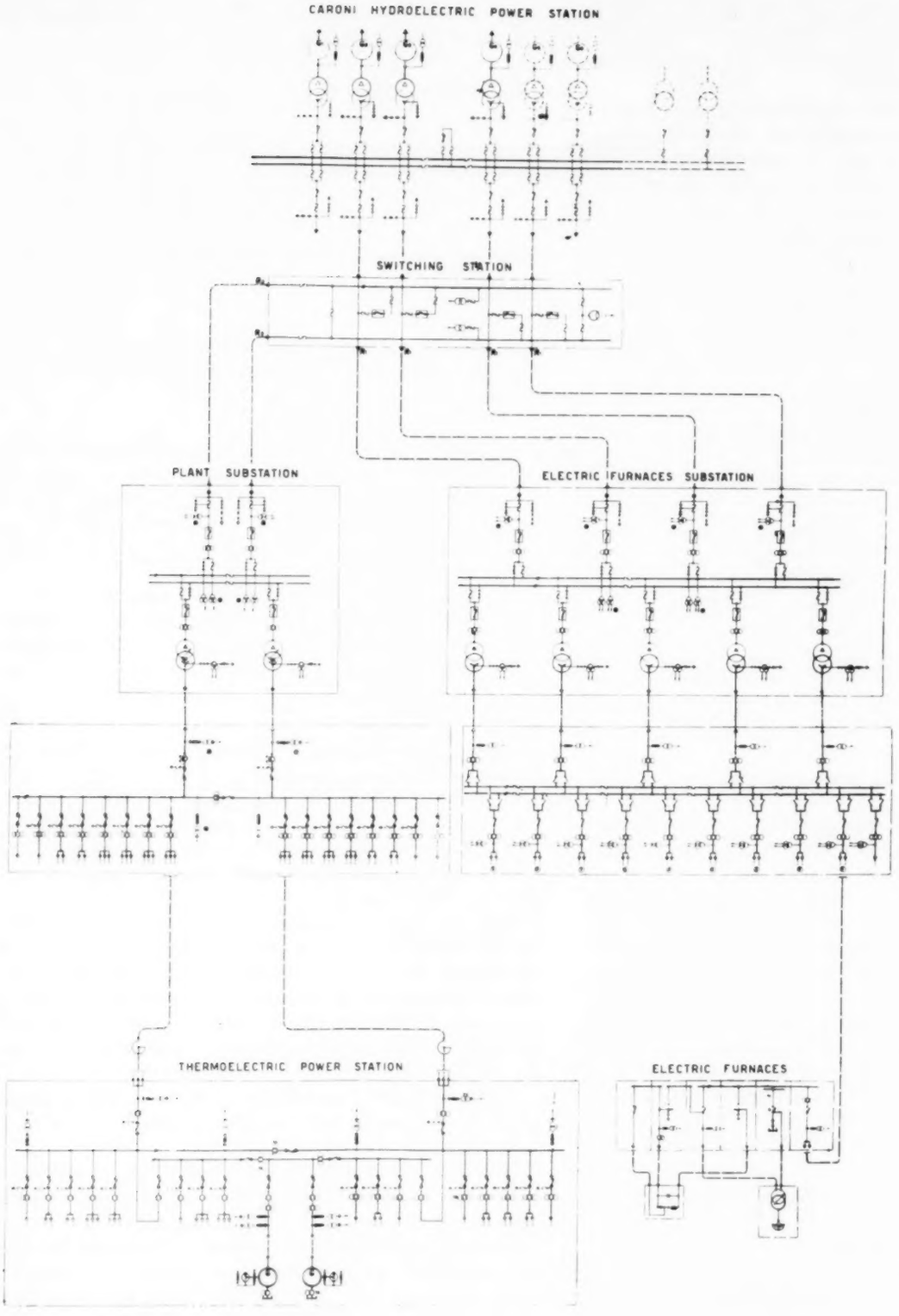


Figure 17 — Single line diagram of plant electrical distribution system.

substation (R2) for all the other needs of the works.

Electric furnace substation (R1)—This steps the incoming power down to 22-kv through five 55,000-kva transformers and a double bus bar system on the 11.5-kv side. Also on the 22-kv side there is a double bus bar system to which 11 lines are connected for feeding at 22-kv the nine electric smelting furnaces, the electrode paste plant and the electric furnaces of the foundry.

Works substation (R2)—This is equipped with two 40,000-kva transformers stepping the power down from 115 to 13.8 kv. It is fed by the two 115-kv lines coming from the switching station through a double bus bar system. On the 13.8-kv side, however, there is a single bus bar system with feeders to the various departments (seamless pipe mill, blooming mill, 800-mm (31.4 in.) mill, 500-mm (19.6 in.) mill, wide-rod mill and thermoelectric power plant). All these feeders are double and symmetrically located.

Thermoelectric power plant substation—As said above, a power plant equipped with two boiler-turbogenerator sets feeds the privileged services of the works.

Excepting the rolling mills and the seamless pipe mill, which are fed directly by the R1 substation, the feeders to all the other departments and services are centralized in this substation.

Two 13.8-kv incoming lines from R2 substation feed a bus-bar (1); from this the feeders for the various departments and services depart as well as two feeders for a second bus bar to which the two generator sets of the power plant are connected. From this second bus bar the lines feeding only the privileged services depart. Such services may be fed by bus bar (1) and bus bar (2). These two bars are generally not in parallel but may be put that way. All this distribution is at 13.8 kv. From here the department distribution is done through local substations which distribute at 4160-volt and 440 volt, 60 cycles.

Department substations—From the above substation switchboard double feeders depart for feeding the various department substations.

The plant distribution system has been divided into six zones each of them being fed by two feeders from which the department substations of the same zone are derived. The zones are the following:

Zone 1—Process water and pier.
Zone 2—Electric furnaces auxiliary services.
Zone 3—Open hearth, coke plant and coal yard.
Zone 4—Foundry auxiliaries, wire drawing, seamless tube mill auxiliaries, main office building.
Zone 5—Maintenance shop, five substations for rolling mill auxiliary services.
Zone 6—Ore stockyard and sintering.

The double feeders to the substations of zones 1, 2 and 3 are derived, one from bar (1) of the thermoelectric substation (fed by outside current) and the second from bar (2) of the same (fed by the turbogenerator).

The feeders to the substations of zones 4, 5 and 6, however, are derived by bar system (1) fed by outside current.

The 13,800/440-volt transformers of these substations have beea standardized in two classes: 1500 kva and 1000 kva.

Summing up, the electrical distribution throughout the plant is done as follows:

Alternating-current system:

At 22 kv only for the electric furnaces (transformers of the furnaces).
At 13.8 kv for some high capacity drives and for the transformer substations.
At 4160 volt for the normal industrial uses.
At 440 volt for the low-voltage circuits.

The motors above 5000 hp [the motor-generator set with flywheel motor, the 800-mm (31.4 in.) mill motor-generator) set motor] are at 13.8 kv. Motors from 300 to 5000 hp are at 4160 volt. Motors under 300 hp are at 440 volt.

Direct-current system—For the main drives of the rolling mill, direct current is generated by proper sets or rectifiers. For some mill auxiliaries (blooming mill screwdown, manipulators, mill tables), where reversals are frequent, d-c variable voltage sets have been adopted. For other services (other mill auxiliaries, steel shop cranes) constant 230-volt direct current is used.

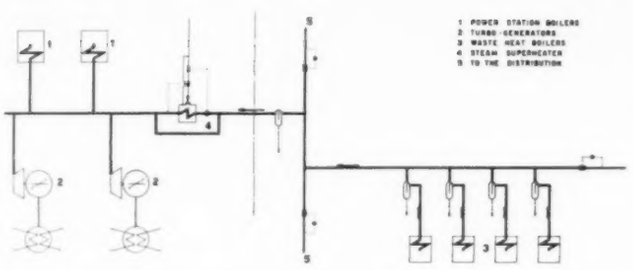


Figure 18 — Steam generator and distribution schematic.

Electric lighting—The plant lighting consists of two systems:

a. Roadway lighting is done through lanterns being mounted at about 11 m (36 ft) with an approximate spacing of 30 m (98.5 ft). Lamps, 250-w each, are used within Zeiss bowls, and the illuminating intensity is about 15 lux (1.5 foot-candles).
b. Yards are illuminated by projectors mounted on platforms at the top of 20-m (65.7 ft) self-supporting towers. The projectors can be oriented and are fitted with 1000-w mercury lamps. The illuminating intensity is about 15 lux.

Steam generation and distribution—This is shown in Figure 18.

Thermoelectric power plant—As said above, the power plant consists of two 30-ton per hour, 30-atmosphere, 400-C (742 F) boilers and two 3-phase, 7500-kva, 13.8-kv, 60-cycle generators driven by 30-atmosphere, 380-C (717 F) steam turbines.

This electrical generating plant has been planned in view of insuring safe operation of the vital services of the works. In fact the power plant will be operating round-the-clock to generate—on a separate system—only that portion of power needed for feeding a part of the privileged services (pumps, steel shop and electric furnace d-c cranes, gas exhausters).

The expansion of the power plant, in case of enlargement of the works, will be done through the addition of other boiler-turboalternator set.

The boilers will be fired with electric furnace and coke oven gases available after works demands have been satisfied and with fuel oil for the balance.

Open hearth waste heat boilers—The open hearths are equipped with water tube waste heat boilers. These too have been designed for a working pressure of 30 atmosphere; the super heated steam will be supplied at about 350 C (662 F). From each boiler an average steam generation can be expected of six to seven tons per hour. Altogether there will be about 24 to 28 tons per hour of steam availability with four open hearths operating and about 18 to 21 tons per hour when one of the open hearths is under repair.

As the works' uses (fuel oil preheating and atomizing, coke plant by-products, pickling bath heating and others) will require abut 15 tons per hour, there is a surplus of steam generated by the waste heat boilers available for other uses.

Steam distribution system—Provision has been made

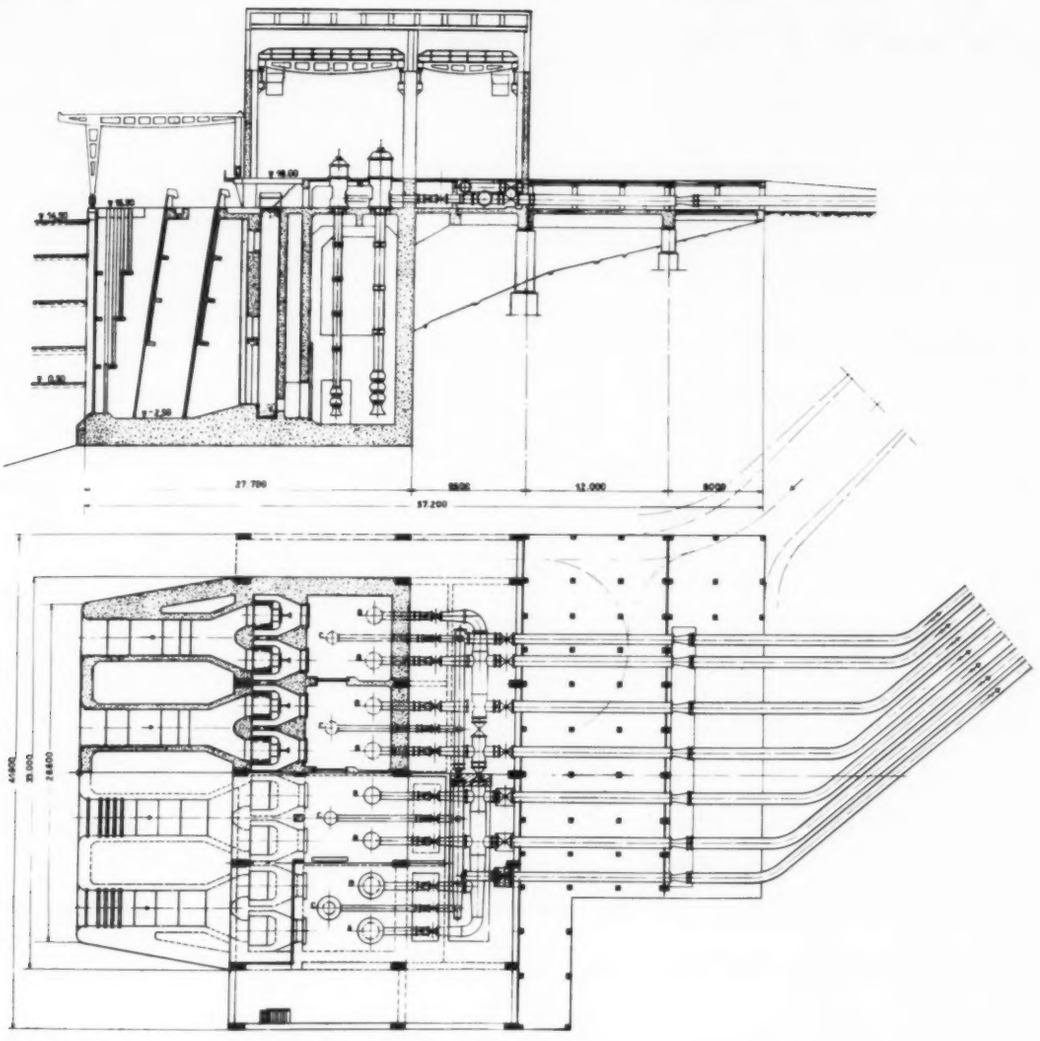


Figure 19 — This pump house supplies process and power house water.

for the installation of a steam main operating at 30 atmosphere linking the waste heat boilers with the power house. Every available amount of steam from the waste heat boilers will be used for driving the turbines of the power house; conversely, were all or part of the waste heat boilers not operating, the power plant will supply steam to the network. In this way a balanced system has been realized.

On the main many steam traps are fitted; at the entrance of the main into the power plant an independent superheater is installed for restoring the steam conditions for use in the turbines.

From the aforesaid main, through pressure throttling valves, the network is derived for the distribution to the works' uses at 15 atmosphere.

Process water system—Shown in Figure 19 is the pump house.

The requirement of cooling water for the various departments and services is about 18,600 to 20,600 cu m per hour (81,800 to 90,700 gpm) of which 16,600 (73,000) are used in the main productive departments and 2000 (8800) to 4000 (17,600) in the condensers of the power house.

To meet this requirement a huge intake was erected, consisting of a large caisson 33 m (108 ft) long and 27.7 m (91 ft) wide sunk in the river bottom near the bank. This intake which is built for an ultimate capacity of above 45,000 cu m per hour (197,000 gpm) is divided into four longitudinal sections, each one provided with gates, grates and filters. The pumps, of the submerged type with long vertical drive shaft, are located within pits having a section of 7.2 x 7.35 m (23.6 x 24.1 ft) and a depth of above 18.5 m (60.8 ft).

The caisson bottom is 2.5 m (8.2 ft) under the lowest river level. The caisson top is at 15 m (49.3 ft) above. Altogether it is 17.5 m (57.5 ft) high, the river level difference from low to high water is about 13 m (42.7 ft).

In each pit there are fitted three pumps. Room has been left to add five more units. The process water (16,600 cu m per hour) (73,000 gpm must be pumped at a pressure of 118 m (380 ft) [45-m (147 ft) static head + 25-m (82 ft) friction loss + 48-m (157 ft) pressure on works floor].

The cooling water for the power station condenser (2000 to 4000 cu m per hour) (8,800 to 17,600 gpm) will be pumped at a pressure of 82 m (269 ft) [45 (147.5) + − 17(55.7) + 20 (65.6 ft) respectively].

In that way there are two separate systems of cooling water: one for the plant and one for the power station. For the first one, four 4700 cu meter per hour (20,700 gpm) pumps and one 2500 cu meter per hour (11,000 gpm) pump are provided, for the second three 2000 cu meter per hour (8800 gpm) units.

Distribution to the plant is done through three piping systems with 900 mm (35.3 in.) diam (in the future five) and one with 800 mm (31.4 in.) diam (in the future two)

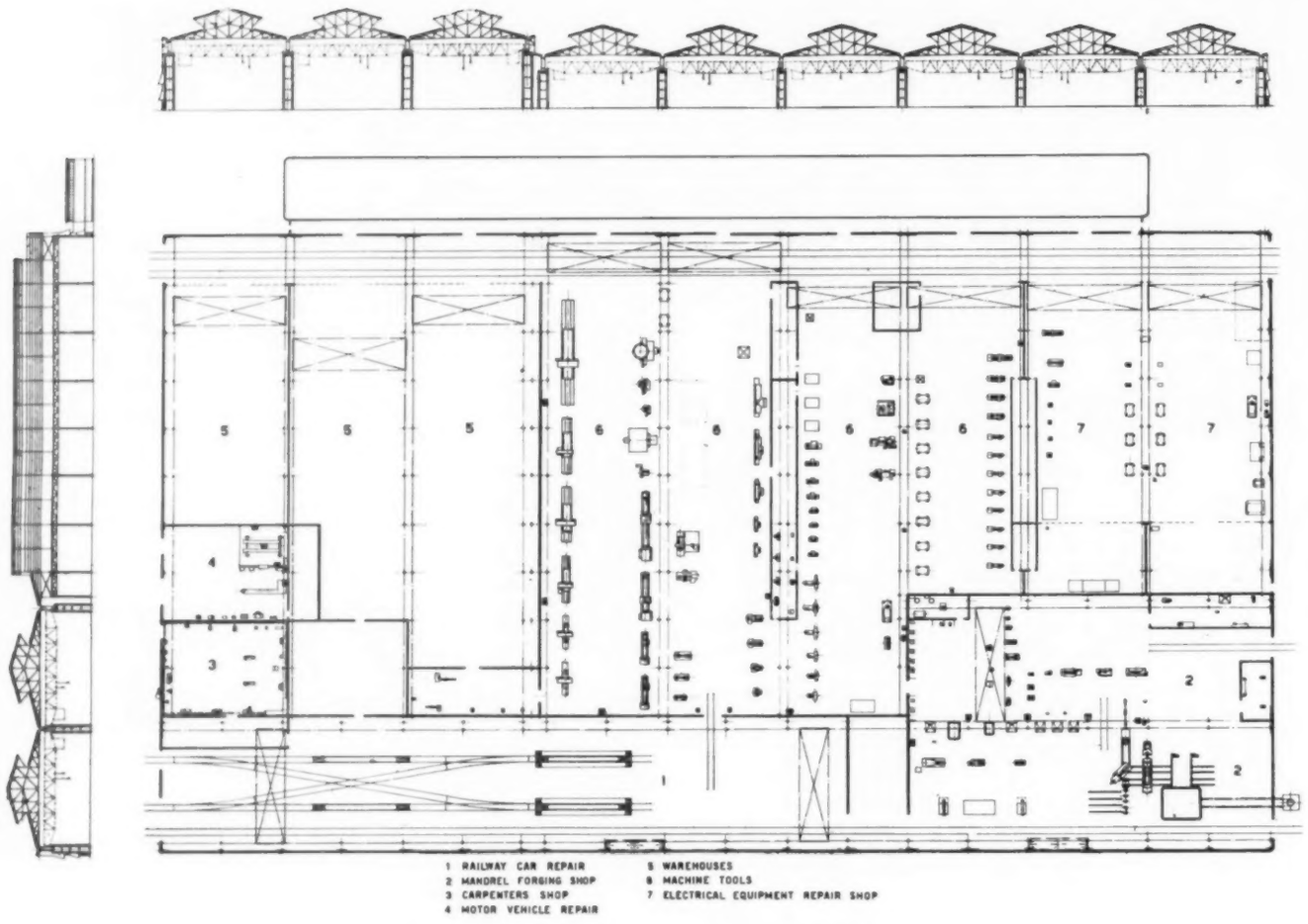


Figure 20 — Floor plan of the mechanical shop.

respectively, departing from the main headers sectionable in various sections. The main pipes are provided with suitable equipment to attenuate water hammer (bottles fitted with check valve, by-passes and air inlet valves). From the three aforesaid mains, water is delivered to a distribution station (valve house), from which it is supplied to the various departments through a loop system. By operating valves and by connecting adjacent loop systems it is possible to isolate any section of piping for repairing and other purposes without interrupting the service.

A 3500 cu meter (925,000 gal) piezometric water tower in reinforced concrete assures a constant pressure and water supply to the plant for about 12 min; this time is broadly sufficient to start other pumps or to switch any of them in either of the two electric systems.

In fact the operation is foreseen as follows: one part of the pumps is fed by external power, the other by the power house. These two electrical feeding systems are independent and do not work in parallel. Therefore, in case of a shutdown of one of the two systems, the other part of the pumps will not be discontinued and the piezometric reservoir will allow the operators to make the proper switching.

Gas distribution—The gas distribution throughout the plant is done through two separate systems: one for the reduction furnace gas and the other for the coke-oven gas.

The electric reduction furnace gas has a heating value of 2500 cal per Nm^3 (0.281 Btu per cu ft) and consists mostly of CO; its output is 450 and 650 Nm^3 per ton (1580 to 2290 cu ft) of pig iron. Each of the reduction furnaces is equipped with a booster and a scrubber so that the gas is delivered into the network washed and cleaned. It is distributed so as to be used mostly as soaking pits, continuous reheating furnaces of the rolling mills, sinter plant, coke ovens and finally at the power house in which all the excess resulting is burned. The main distribution pipe has 1600-mm (63 in.) diam.; it is connected to a 20,000-cu m (707,000 cu ft) gas holder.

The coke-oven gas has a heating value of 4.800,000 cal per Nm^3 (540 Btu per cu ft), and its output is about 350 Nm^3 (11,200 cu ft) per ton of coal. It is distributed to the coke-oven plant for heating the ovens and to the steel shop for firing the open hearth furnace. The portion of gas for the steel shop is desulphurized. Possible excess resulting from above is used in the power house. The distribution main has 1200-mm (47 in.) diam, and it is connected with a 20,000 cu meter (707,000 cu ft) gas holder.

For both the mill reheating furnaces and the open hearth, together with the gas, some fuel oil or tar will also be use to carburize the flame and make it luminous. The seamless pipe mill furnaces are only fuel oil fired.

In arrangement of the two gas distribution pipe systems the possibility of adding a third main for blast furnace gas has been taken into account in case the pig iron output expansion be eventually realized through the installation of a blast furnace instead of more electric furnaces.

The three gas systems are kept separated, and the possible mixtures are made at the consumption centers.

Fuel-oil distribution system—Owing to the plant location, fuel oil, supply is done through large tankers coming from the ocean. Therefore one big tank, having a capacity of 6000 cu m (1,580,000 gal) will be installed outside the plant site on the river bank and near a docking point for which it is contemplated to use a barge, properly adapted, which during the erection of the plant has been used as a provisional pier.

A pumping station and a pipeline will feed a 1000 cu meter (264,000 gal) tank installed centrally in the plant area. From this fuel oil will be distributed to the consumption centers.

Transportation—Raw materials, sinter and coke are all handled by belt conveyors from disembarcation to stocking and from reclaiming to consuming centers.

Hot metal, steel, semi-finished and finished products are moved from one department to another through railroad. The track gage is the standard one, i.e., 1435-mm (4 ft-8½ in.), 100-lb per yard rails and railway material comply with AREA specification. Wooden ties are spaced at 60 cm (23.6 in.) in the heavy traffic tracks (from the electric furnace to the open hearth and to the rolling mills as well as from the pier to the plant) and spaced at about 72 cm (28.4 in.) in the remainder of the trackage. The maximum grade in the track connection between the pier and the plant is 1.7 per cent. The minimum radius is 120 m (394 ft). The total length of the tracks is around 50 km (31 mile). The rolling stock will be moved by diesel-electric locomotives of the double bogie type and with a working weight of 65 and 80 metric tons (88 net tons), for a maximum speed of 30 km per hour (18.6 mphr).

A large roadway network allows for a considerable internal traffic by trucks complying with the present trend in modern plant transportation.

Maintenance shop—An over-all scheme has been developed for the maintenance department (Figure 20) so as to make it the basis for a centralized maintenance system, keeping in mind the special requirements which will be encountered in an integrated iron and steel plant and particularly for one located in a relatively new region situated at a considerable distance from sources of supply.

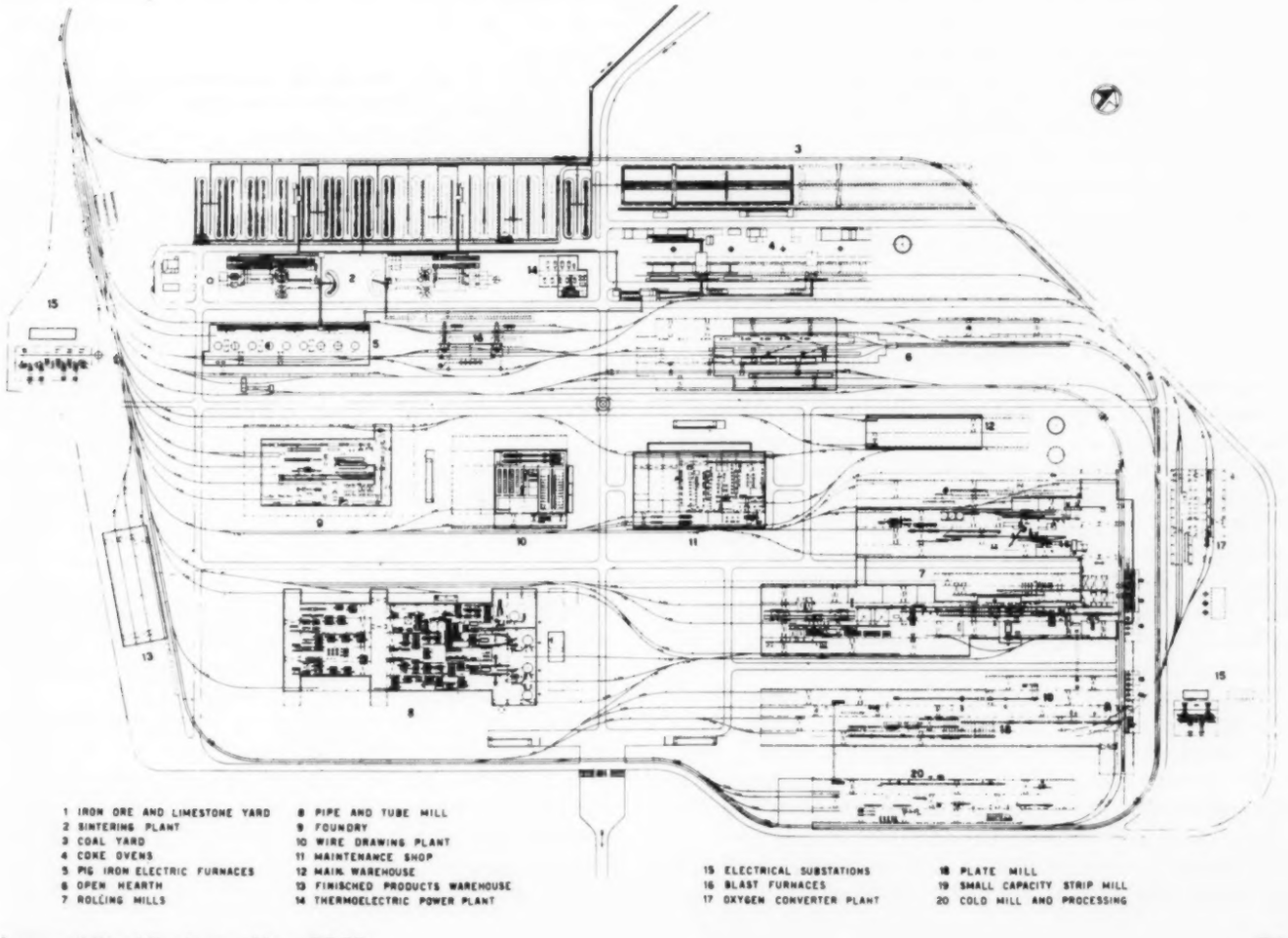
Besides the machine tools proper there is also a forge and blacksmith section. A section for manufacturing and repairing electrical equipment, a section for repairing rolling stock and motorcars, carpenters and cabinetmakers section, etc.

The maintenance building, in tubular steel structure, represents 29,000 sq meters (311,000 sq ft) (228 x 127 m) (749 x 416 ft) and is divided into 11 bays with 11 overhead traveling cranes.

OFFICES AND PERSONNEL SERVICES

Main office building—The main offices of the plant

Figure 21 — This plan shows some possible future expansions which might be made to attain an ingot capacity of 1,500,000 tons per year.



will be housed in a large 8-story building in reinforced concrete located in an elevated position on the access road to the plant. In this building all the offices will be housed for plant management, general engineering, accounting, drafting rooms and research laboratory.

For local administration each plant department is provided with its own office block conveniently situated.

Personnel services—Four separate buildings are in the course of construction containing sanitary facilities and locker rooms. Each of them is sized for 800 persons and is located in a proper position near the relative departments.

PRELIMINARY STUDY ON POSSIBLE FUTURE PLANT EXPANSIONS

In this second plan, Figure 21, some possible future expansions are indicated to attain the ingot steel capacity of about 1,500,000 metric tons (1,650,000 net tons) per year. However, it is to be pointed out that for the time being it is only a matter of planning indicating eventual possibilities.

The increase in output of pig iron is contemplated with blast furnaces. Room has been left for two units. On the same alinement as the present coke ovens other batteries would be built to be fed with high grade coals suitable for making metallurgical coke. These batteries would be of the fully conventional type.

The coal yard would be prolonged accordingly. The ore yard would be doubled: an arrangement in a sense symmetrical to the present one has been contemplated. That way, there would result another complete group—storeyards, sinter plant, blast furnaces.

For the increase of steel production contemplated in the field of flat rolled products, the installation of an oxygen top-blown converter steel shop has been envisaged. Its location is indicated in the plan of Figure 21. Room has also been left for additional open hearth furnaces.

As of today there is no final program concerning the future expansion of the rolling mills. We have studied a possible expansion plan which specially keeps the door open to any possible manufacture of a wider range of steel products.

In the plan of Figure 21, the installation is indicated of a 360-mm (14.1 in.) merchant mill, which, as far as the product range is concerned, would fit well between the two existent 500-mm (19.6 in.) and 300-mm(11.8 in.) mills. A continuous billet mill is contemplated for feeding the three aforesaid mills and eventually selling billets to others.

We have also indicated the possibility of installing a 4-high reversing stand followed by a tandem continuous mill for rolling heavy plates and coils.

This semi-continuous unit could be fed by slabs prerolled from slab ingots at the same reversing stand and from slabs rolled at the present blooming mill. Some heavy plates could also be rolled directly from slab ingots.

The hot rolled strip may be partly hot finished and, for the remainder, cold finished. An underground transfer could bring the hot strip coils to a cold rolling and finishing department of proper capacity.

As already stated, all of this is just a matter of general outline giving various potential solutions.

OVER-ALL STATUS OF ENGINEERING AND OF CONSTRUCTION WORK

In the Milano offices of our company the general engineering was almost finished, in September, 1958. The numerous detailed studies were underway. All of the most significant orders were placed.

A works management controls the erection and setting up of the plant at the field.

The layout of the plant was established in the meetings held in Caracas in October, 1956, and January, 1957, by the Venezuelan authorities, the engineers and ourselves.

The works in the field were actually started in March, 1957.

On April 20, 1958, the first seamless tubes have been rolled at the large mill. The buildings for the warehouses, wire drawing plant, iron foundry, maintenance shop and seamless pipe mill have been completed.

As of September, 1958, more than 3000 men were working in the field. The pier was built to a length of 80 m (262 ft). The erection of the electric reduction furnaces was started. The foundation of the open hearth shop was underway. The erection of the rolling mills building was also started. General services and facilities installation was underway.

All the works will be in the main finished by June, 1960, and during the following three to four months all the departments will be ready to operate.

Discussion

PRESENTED BY

L. A. LAMBING, Steel Making Consultant, Loftus Engineering Corp., Pittsburgh, Pa.

E. J. GRACE, Manager of the Steel Mill Dept., Westinghouse Electric International Co., New York, N. Y.

O. BRAATEN, United States Branch Manager, Elektrokemisk A.S., New York, N. Y.

R. H. TURNER, Chief Electrical Engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.

Dr. M. GONNI, Manager, Engineering and Construction Div. Innocenti S. G., Milano, Italy

J. R. MILLER, President, J. R. Miller Co., New York, N. Y.

L. A. Lambing: The Venezuelan Steel Works, when completed, must be ranked among the large steel plants in the world with an annual ingot production in the neighborhood of 1,650,000 net tons.

This steel plant will operate on a high percentage of hot metal. Fortunately, the iron will be low in silicon so that it should not cause too much trouble. Because of this low silicon iron the amount of limestone to be charged will not be excessive although the iron charge will be high.

The blooming mill with its drive and controls is of

American design and manufacture, and the open hearth furnaces and soaking pits are of American design.

E. J. Grace: My company is privileged to supply major portions of the electrical drive equipment for the 44-in. reversing blooming mill, the billet, rail and structural mills and the 12-in. semi-continuous rod and merchant mill.

The 44 in. reversing blooming mill will be of conventional American design, with 8000-hp, twin-motor drive and with variable voltage auxiliary drives for the tables, manipulators and screwdown.

The 8000-hp twin drive consists of two 4000-hp, 40/100-rpm, single-armature motors for the separate drive of the upper and lower rolls without a pinion stand. The lower roll will be driven by the motor nearest the mill with the upper roll motor driving through a jack shaft over the top of the lower motor. Power for the main motors will be supplied from a 7000-kw flywheel, motor-generator set feeding each 4000-hp motor. The motors and generators are controlled by rotating regulators to provide the forcing and speed of response to enable a 1½-sec reversal from base speed forward to base speed reverse.

The 22-stand semi-continuous rod and merchant mill is of German design, but the arrangement has many points of similarity with recent American mills.

The roughing and intermediate stand No. 1 to 12 are arranged in a continuous line, with stands No. 1 to 6 driven in pairs by two 700-hp and one 1000-hp motor. Stands No. 7 and 12 are individually driven by six 700-motors. Following the 12-stand continuous roughing and intermediate mills are looping stands No. 13 to 16 which are individually driven by 800-hp motors. The continuous finishing mill, stands No. 17 to 22, is driven by a 1500-hp motor.

This is a 2-strand mill, and provision is made to deliver finished bar and rod from looping stand No. 16 or from finishing stands No. 18, 20 or 22. The bar or rod from any of these delivery stands may go to a group of four reels, or to a flying shear, runout table and cooling bed.

Power for the 14 main motors is supplied by three pumped tube ignition rectifiers. The three roughing mill motors driving stands No. 1 to 6 are supplied by a 1500-kw rectifier. The transformer for this rectifier has tap changing under load as it is contemplated that many schedules will require reduced voltage operation of the roughing mill. The six motors driving stands No. 7 to 12 are supplied from a 3000-kw rectifier and the four 800-hp looping stand motors, and the 1500-hp finishing mill motors are supplied from another 3000-kw rectifier. The three rectifiers operate independently without any interconnecting bus ties.

The rectifier voltages are regulated by 2-stage, 400-cycle magnetic amplifier type of voltage regulators, and each of the 14 motors is controlled by a 400-cycle magnetic amplifier speed regulator. The regulators provide the accurate speed matching and very fast recovery from impact speed drops when a bar enters the mill to enable successful 2-strand operation with individual motor drives on most of the mill stands.

O. Braaten: As far as the pig iron production is concerned, electric reduction furnaces are installed instead of the conventional blast furnaces. The electric furnaces are supplied by us, and they are of the same size as the four units of 33,000-kva capacity installed in Mo-i-Rana, Norway, and already in operation for some years.

The first one of them was started about 3½ years ago. The system of Tysland Hole was invented in the early twenties, and the first furnaces of that type were installed in 1928.

Today, 32 Tysland Hole furnaces of our make are in operation, and 19 are under construction, among them are these nine furnaces in Venezuela.

R. H. Turner: In this country tubular type construction for mill buildings is a very radical departure. In fact, there is no place in this country where we have mill buildings with the columns, crane girders and roof structures made of tubular steel. I wonder if you can tell us the economic and engineering considerations which lead to this selection.

M. Gonni: It has been proved, for the light building, that tubular frames are economical. Wherever you do not have heavy roofs or to resist heavy forces the tubular frames are superior from an economical point of view.

J. R. Miller: The international participation in this project has required bringing into harmony the best features of engineering thought and talent from half a dozen countries. In doing this, Dr. Gonni has had to deal with the metric and English systems, Italian UNI standards for structural shapes and American API and AREA specifications for tubular products and rails. He has had to handle a combination of design and construction specifications from Venezuela, Italy, the U. S. and Germany. Correspondence and drawing notations are in Spanish, Italian and English.

Another feature worthy of note is that the 750,000-ingot ton plant which is now being built in Venezuela is so designed that the service facilities which are being installed initially are oversized and adequate for an ultimate production of 1,200,000 tons. This 70 per cent addition in capacity will largely benefit these provisions. At the 1956 meeting of the Economic Commission for Latin America in Sao Paulo, it was noted that nearly every major steel plant built in South America since 1942 has found it necessary to expand before the original plant was completed. The expansions which have since been undertaken were made at greatly increased construction and equipment costs.

The problem can be summarized by citing a statement that, under the prevailing market conditions, equipment provided within any plant designed for Latin America may be selected in sizes considerably beyond the level at which operations will start, being limited only by an analysis of whether or not it is preferable to make any initial outlay of funds greater than absolutely necessary in order to gain greater advantages later.

Up until now no country in Latin America has been able to avail itself of such potential advantages because of financial limitations. It will be interesting to steel plant management throughout the world, and particularly here in the United States where the availability of funds for capital investment is somewhat less restricted, to see how much time passes before the new steel plant in Venezuela requires the use of its built-in excess potential and how much this will save them in capital cost at that time. ▲

Republic's Flat

DURING the past three years, construction activity at the Gulfsteel plant of Republic Steel Corp. at Gadsden, Ala., has resulted in increased ingot capacity and new flat rolling facilities that have modernized the production of galvanized sheet products and enabled the plant to start on a new line of hot and cold rolled strip.

The expansion program was planned in three parts; the first part consisted mainly of equipment for producing strip, and the latter parts were concerned with increasing ingot capacity. This paper considers mainly the flat rolling facilities.

The reason for installing new equipment was to modernize the operation by replacing old hand mills and single, hot dip galvanizing pots with continuous strip mills and a continuous galvanizing line. This was due to the increased demand for cold rolled strip and galvanized sheets and coils which could not be produced at this plant.

At the blooming mill, which is a 2-high reversing unit, a new 52-in. pinion stand was installed, so larger ingots could be rolled to get a 49-in. wide slab. The front table was altered, and the manipulator was rebuilt; a new shear was installed capable of cutting a slab $6\frac{1}{2}$ x 50 in. at 13 cuts per minute. Also, a new scale, a marking device for slab identification, and a new pusher and slab piler were installed. The slab yard was rebuilt, and a new crane installed to handle larger lifts.

A gantry crane was erected to transfer slabs from the cooling storage area to the scarfing yard ahead of the reheat furnaces. A new slab yard was built for preparing slabs and is serviced by two overhead cranes for charging material onto two top discharge, hydraulic magazine depilers which are sectionalized to handle short slabs for skelp and plate rolling and longer slabs for strip. The pushers ahead of the depilers are capable of handling either single or double rows of slabs.

Three small slab heating furnaces were replaced by two new larger furnaces designed for 100 ton per hr capacity. They are triple-fired, recuperative, end-charge and discharge; have an effective hearth length of 80 ft 0 in. and width of 19 ft 0 in. The furnaces are designed to use natural gas, coke gas or fuel oil. Each unit has two metallic tube type recuperators for preheating combustion air. They are equipped with fuel-air ratio, fuel input, automatic temperature and pressure controls; natural and coke gas combination pressure and total gas recorders, fuel oil temperature integrating meters and oil pressure gages; a coke oven gas recorder with low pressure alarm; a waste gas and combustion air temperature and recuperator temperature recorder.

The slabs are discharged to the mill delivery table in front of the furnaces and are given one pass on a horizontal scalebreaker, newly installed, then rolled down on a 3-high mill. This is a 112-in. universal mill, and reversing for passes is done by front and back tilting tables. Slab sizes range from 24 to 49 in. wide and $3\frac{1}{2}$ to $4\frac{1}{2}$ in. thick.

Since the 3-high mill not only rolls plates and skelp for the pipe mill but also is the roughing mill for hot strip, the construction of the new facilities presented a special problem to maintain production of plates and skelp. While preparation for the hot strip mill was under way, foundations for the plate line had to be installed and the equipment moved to the new location. The planning required close scheduling and co-ordination with both the mill and construction crews.

The plates run from the 3-high mill and move 159 ft to the cooling bed, which transfers them to the plate preparation line. The transfer is also a holding table with sprays at the exit end for temperature control of plates. In this line is a leveler, inspection table, end-cut shear, rotary side shears and plate or skelp racks for stacking for removal by overhead crane.

The new hot strip mill has four, 4-high finishing stands, spaced 18 ft 0 in. between stands with 25-in. diam work rolls and backup rolls 49 in. diam with 54-in. roll face. Each stand is driven by a 3500-hp motor. The first two stands are driven through a gear reducer to a pinion stand while the last two stands are direct-driven to the pinion stand. The crop shear ahead of the first stand is 215 ft 7 in. from the 3-high rougher, and the first stand is 41 ft 7 in. from the crop shear; this distance was allowed in event of a future No. 1 stand. The oil basement houses such auxiliary units as tanks, pumps, filters and coolers for lubrication of the mill. The runout table has 162 individually driven rolls spaced 2 ft 0 in. apart for a length of 324 ft to the coiler where the strip is wound on a paddle reel mandrel at speeds from 1130 to 2260 fpm. The coil is then stripped to an upender and deposited on a conveyor where coils are weighed, marked and otherwise identified at this point then transported to crane access for storage. The range of thickness from this mill is from 0.072 to 0.250 in. with widths from 24 to 48 in.

After cooling in storage, the coils are deposited by overhead crane onto a receiving conveyor, which transfers them to a downender. The coils are then conveyed to the pickle line. The entry end of the pickel line consists of a processor for unwinding and leveling, a shear to square the ends, a butt-welder to build coils to a maximum of 40,000 lb, a flash trimmer, and pinch rolls to feed the strip into the looping pit ahead of the acid tanks. This is a cascade type line where the pickle solution overflows from tank to tank and drains from the strip entry tank. An auxiliary scale-breaker is being installed to better utilize the pickle tanks to clean and etch the strip. The entry section of the line is powered to operate at 750 fpm, and a speed of 300 fpm is possible through the remainder of the line. The exit end has pinch rolls, a shear, an up-coiler and a scale at the discharge ramp.

The steel is taken away from the pickle line either

Rolled Expansion In The South

L. S. Mobley,
Chief Engineer,
Southern District
Republic Steel Corp.
Gadsden, Ala.

Alterations and additions to an existing blooming mill were made so that larger ingots yielding 49-in. wide slabs could be rolled . . . . new units installed include a 4-stand, 4-high tandem cold reducing mill; an annealing department; a single-stand, 4-high temper mill; and a continuous galvanizing line.

by overhead crane or tractor and placed in storage or delivered to the tandem mill where the coils are placed on a conveyor 30 ft long and delivered to a coil opener, which straightens the end and makes it ready to feed into the mill.

The tandem mill is a 3-stand, 4-high mill with 21-in. diam work rolls and backup rolls 53 in. diam with 54-in. roll face. Each stand is driven by a 3500-hp motor directly coupled to the pinion stands, and the reel is driven by a 1000-hp motor. The mill is able to reduce thickness of steel 80 per cent by a combination of pressure and tension at speeds from 962 to 2062 fpm. An automatic screwdown control is installed on the first and last stands for gage control. The auxiliary units in the oil basement are those normally required for operation of a mill of this type and include a coolant mixing tank, a coolant tank, pumps, filters and coolers, an oil system for the backup roll bearings, a lubricating oil system for screwdown and pinion stands, a roll balance hydraulic system, a hydraulic system for entry and exit equipment, screwdown controls and a fog exhaust system. The steel is wound on a 24-in. diam reel mandrel by a belt wrapper, and when the coil is completed it is stripped and placed on a ramp against retractable stops for banding and then rolled to an upender, deposited on a conveyor and transferred to the annealing building.

The annealing facilities consist of 50 bases and 20 furnaces of the single stack, radiant tube type. The coils are stacked on a base to a maximum of 162 in. high. A convector plate is placed between each coil and an inner cover placed over the stacked material; the bottom is sealed by sand and the furnace proper placed over all. Deoxidized gas is provided to the inner covers by three generators. Temperature for each furnace is controlled from a central pyrometer room and recorded on individual charts. After the heating cycle, the furnace is removed and a special cooler placed over the inner covers, and the steel is cooled slowly for approximately 50 hr. Ventilators in the monitor of the building help exhaust heat. After cooling, the coils are taken by overhead crane to a conveyor for transfer to storage or to the temper mill.

The coils go on a downender at the temper mill and are lifted by an entry crane and placed on an elevator at the uncoiler. The temper mill is a single stand, 4-high mill with work rolls 21 in. diam and backup rolls 53 in. diam with 54-in. roll face. The mill motor is 1000 hp and the reel is driven by a 1200-hp motor capable of speeds up to 3000 fpm. The steel is wound on a mandrel by a retractable belt wrapper; and when the off-gage section of the strip is approached (which is the entry end through the tandem mill), the mill is stopped, the strip is sheared, and the finished coil is stripped and placed on the exit conveyor. The coil is again weighed and tagged. It is now ready for shipment, if in coil form, or for further processing and shearing. The scrap end is taken from the mill and the unit is ready for the next coil.

From the temper mill the coils are taken by overhead crane to the galvanizing line, or by trailer to the shearing department.

The galvanizing line essentially is composed of three main parts: strip preparation, coating and shearing. The strip preparation section consists of two uncoilers, an up-cut shear, a lap welder, a side trimmer, a scrap baller, pinch rolls, an entry bridle, a thickness gage, a pin hole detector and a looping pit 73 ft deep for the strip run during welding. The cleaning area consists of two muriatic acid tanks, two spray and dip tanks, three scrubbers and one alkali cleaning tank. After passing through a flux tank, the strip goes up through a tower which bakes the flux on the upward pass and preheats the strip on the downward pass before entering the

pot. The galvanizing pot is ceramic lined, heated by six inductors. The strip is held in the pot by a rig which contains the sink rolls and plating rolls. As strip emerges from the molten zinc, the plating rolls distribute the metal evenly over the surface. The coated steel continues into a tower some 50 ft above the operating floor and is air-cooled by five wind boxes, each with a separate fan. The strip returns to the floor, around a deflector roll, into a chemical treatment tank, a rinse tank and through hot air dryers being pulled from the entry looping pit by a drive bridle. A second tension bridle pulls the strip from the exit looping pit 50 ft deep which is utilized for strip storage while the coil is being sheared and stripped from the coiler, which was installed to wind coated steel to customer specifications. The coiler can be by-passed by carryover conveyor to a flying shear which is adjustable for lengths 3 to 14 ft. The exit end of the line consists of belt conveyors, a leveler, a classifier, an auxiliary piler, a prime piler and the runout pack conveyor with a scale.

The shearing department at this time consists of three lines—cold strip cutting, hot strip cutting and a multiple-strand slitter.

The cold strip line can handle gages 0.015 to 0.125 in. and 18 to 48½ in. wide and cut sheet 2 ft 6 in. to 20 ft 0 in. long. It consists of a mandrel uncoiler, a side trimmer, a scrap baller, a flying shear, a runout table and a piler conveyor with a scale. Speed of this line is 300 fpm.

The hot strip cutting line takes steel directly from the hot strip mill or the pickle line and can handle gages 0.072 to 0.250 in. and 24 to 48 in. wide and cut sheets 3 ft 0 in. to 16 ft 0 in. long. It consists of a processor, an end-cut shear, a side trimmer and scrap chopper, an up-cut shear, a shear gage, a leveler, a runout table and a piler conveyor with a scale. Speed of this line is 160 fpm.

The slitting line takes coils for finishing from the temper mill and can handle gages 0.015 to 0.134 in. and up to 49½ in. wide. Multiple strands down to 1 in. width are slit at speeds up to 600 fpm. The equipment is a simple installation of an uncoiler, a slitter, a scrap baller and a coiler.

The expansion program made use of existing buildings wherever possible for obvious reasons. However, new structures were erected for the mill motor rooms, the pickle line, and a truck and rail shipment dock in the galvanizing area. Extensive alterations were accomplished in raising and extending the annealing building and adding to the tandem mill, galvanizing and shearing buildings.

Auxiliary units such as pumping stations, laboratories, bearing shops, a roll shop, a cafeteria, a water treatment plant, a storehouse and other necessary structures fell into line in the planning and construction of the new facilities.

Equipment that was to be retained either had to be moved or built around with a minimum of interference in operations. This included the jobbing mill and related facilities, a 2-high cold mill, corrugators and batch pickler.

Sewers, service piping, roads and tracks were planned so as to be ready when required and installed as the program dictated.

Additional electrical power for operation of the new equipment was contracted and necessitated the construction of a new 110/13.8-kv substation. Two parallel overhead lines, 13.8 kv and approximately 1.1 miles long, were erected from this substation to a distribution load center located in the hot strip mill motor room. Power was then routed from this load center to all mills by an underground duct system at 13,800 volt.

Handling equipment had to be either purchased or designed, such as tongs, "C" hooks, magnets, tractors, trailers and other items necessary for the new operation.

Discussion

PRESENTED BY

STUART W. BENSON II, Assistant Chief Engineer, Inland Steel Co., East Chicago, Ind.

L. S. MOBLEY, Chief Engineer, Southern District, Republic Steel Corp., Gadsden, Ala.

Stuart W. Benson II: Most of the major strip mills in the country have six finishing stands. What is the thickness of the bar coming from the 112-in. plate mill prior to going through the four finishing stands?

L. S. Mobley: Naturally, we would like to get it thinner than what it is, but it is now averaging about 0.04 in. Occasionally they get down to 0.375 in.

Stuart W. Benson II: I was also interested in knowing the pounds per inch of width (PIW) which is obtained with this facility.

L. S. Mobley: We are planning for 600 lb per in. width, or heavier.

Stuart W. Benson II: You mentioned obtaining approximately 14 gage in the hot band form. Is that the gage you process through your up-cut lines or do you have to put that through further processing?

L. S. Mobley: In the up-cut line hot strip shearing line we do process this material.

Stuart W. Benson II: Is there any shape problem concerned with the lighter gages since the strip is rolling with only four finishing stands?

L. S. Mobley: There are many problems but experience will help to solve many of them.

Stuart W. Benson II: One other thing I thought was interesting. Your 3-stand mill has a top speed of approximately 2000 fpm. Your temper mill I note, has a speed of about 3000 fpm. Is there any significance in the difference in top speed between the two?

L. S. Mobley: I could answer that question more intelligently if and when we get these mills up to top speed. Actually the type annealing furnaces being single stack we get a "batch," and the higher speed of the temper mill tends to even production to a constant rate.

Stuart W. Benson II: Is the continuous galvanizing line at Gadsden similar to the one at the Warren plant?

L. S. Mobley: That is right. The only difference is that we have six inductors whereas there are four inductors at the Warren plant.

Stuart W. Benson II: Is the width about the same?

L. S. Mobley: The width is the same. It is a duplicate except for some minor changes, to the inductors. No. 1 looping pit is 20 ft deeper, and there are a few alterations gained from experience on the Warren installation. ▲

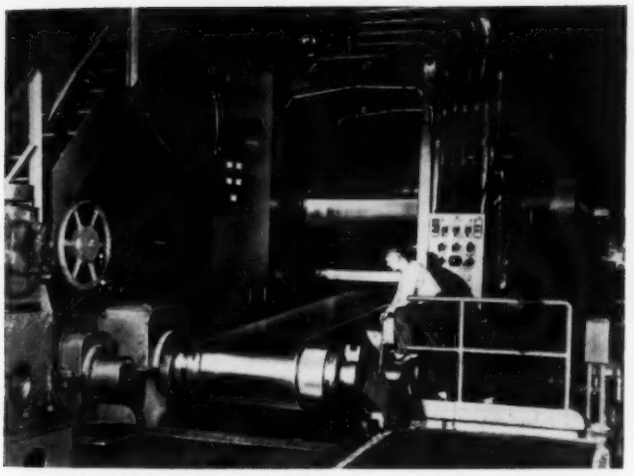


Figure 1 — Most coiled sheet temper rolling is done on 4-high mills such as this one.

Electrical Equipment For A Modern Sheet Temper Mill

by D. E. Rea, Application Engineer, Electrical Application Dept.,
Industrial Equipment Div., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

. . . . only a knowledge of mechanics and possession of sheet work and mill friction test data from similar sheet temper mills are required to accurately calculate the drive power requirements of a sheet temper mill. . . .

THE modern sheet temper mill has become more important in recent years because of increased operating speeds and the higher quality requirements of users of this range of product. Many installations consist of 2-high mills using tables to roll sheared sheet product. These mills flatten, smooth and temper the sheet surface without the aid of tension. Such mills are used for heavier sheet gages.

Most of the coiled sheet temper rolling is done on 4-high mills. Sheet temper rolling is usually done on steel entering the mill at an average of 40 to 45 Rockwell hardness, and the average extension is one per cent. The single stand mill has sufficient ability to meet these requirements. A view of a typical sheet temper installation is shown in Figure 1.

Surface quality, superficial hardness and flatness are imparted to the sheet during temper rolling. To obtain these results a combination of roll pressure and strip tension is used. Mill operators vary the ratio of tension to roll pressure depending on the metallurgy of the steel, shape obtained in the cold reduction mill, and annealing. The electrical equipment must be capable of meeting these different rolling practices. Careful attention must be given to the ability of the entry reel to provide enough back tension. The heavier portions of the strip cross-sectional area can be ironed out with sufficient back pull. With the resulting high back pull pressure, the heavier portions will be extended or reduced to provide a uniform cross section. The electrical equipment powering the reel must have the ability to regulate this tension quite closely to prevent strip breakage or the appearance of stretcher strains. Better cold mill and annealing practice are helping to eliminate some of these problems.

Sheet temper mills are generally arranged with an entry reel, mill stand and delivery reel. A diagram of the mechanical arrangement is shown in Figure 2. This arrangement is used when a variety of sheet gages is to be rolled. A delivery tension puller, as shown in Figure 3, is sometimes added. This device allows the operator to "work" the steel to higher tension values. This is normally used on mills rolling lighter sheet gages when more extension is desired. The tension device is also an aid in temper rolling when poor shape is obtained from the cold reduction mill. Threading of tension pullers with heavier gages is a problem and these are quite often "dummied" when rolling heavy gages.

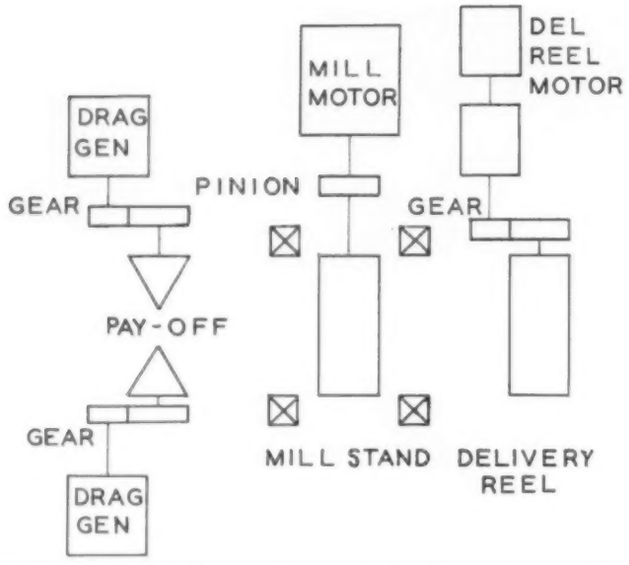


Figure 2 — Typical arrangement of coiled sheet temper mill for rolling a variety of gages.

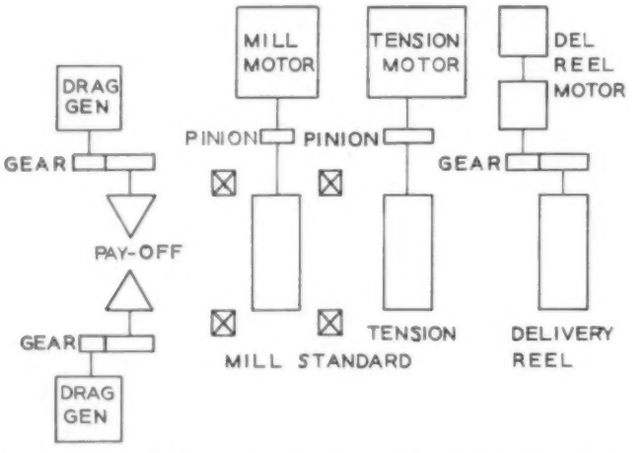


Figure 3 — A delivery tension puller is sometimes added so that the strip can be worked at higher tension levels.

To illustrate the method used in the selection of electrical equipment for an average sheet temper mill, a 60-in. mill was chosen using a cone type entry reel and a mandrel delivery reel. It was assumed the minimum gage would be 0.020 in. thick by 30 in. wide, average strip to be rolled would be 0.035 in. thick by 48 in. wide, and the maximum gage would be 0.080 in. thick by 54 in. wide. The maximum coil weight was selected as 40,000 lb.

This wide range of product was chosen to indicate the range of rolling requirements that the electrical equipment must satisfy. On an average mill approximately 60 per cent of the production would be in the 0.035-in. thick by 48-in. wide product with as little as 10 per cent of the production being 0.08 in. thick by 54 in. wide. Sheet temper mill speeds generally range up to 4000 fpm max. To obtain reasonable production rates a rolling speed of 4000 fpm for the 0.02-in. thick by 30-in. wide product; 3500 fpm for the 0.035-in. thick by 48-in. wide product; and 2000 fpm for the 0.08-in. thick by 54-in. wide product were selected. The mill was chosen using 21-in. nominal work roll diameters with a maximum diameter of 22 in. Backup roll diameter was assumed as 56 in.

Selection of the method of powering the mill is dependent on acceleration limitations. A single-armature stand motor with a pinion stand driving the work rolls is the most common means employed. However, the acceleration requirements may dictate the use of twin drives. Horsepower requirements are usually too large to allow for the direct connection of twin drive motors, and an offset pinion stand is required. The possibility of driving the backup rolls should also be considered.

An entry reel using expanding cones was selected. Enough movement of the cone is provided to allow for poor coil centers. The drag generator can be geared or direct driven. With the use of a mandrel type cone, a means of entering the hydraulic line usually requires a one to one offset gear if a direct drive is used. The delivery reel is provided for both jaw-gripper and belt wrapper. The belt wrapper is used primarily for the lighter gage product. The delivery reel can be direct driven, or a gear can be used. Again consideration must be given to a means for entering the hydraulic line for the mandrel expanding operation.

Figure 4 is the general arrangement of the 21 and 56 x 60-in. sheet temper mill selected for illustration. The entry reel is powered by two 300-kw, 250/900-rpm, 600-volt d-c drag generators through a 1.17:1 gear reduction. They are connected in parallel to a 600-kw, 600-volt d-c generator. The mill stand is driven by a 1250-hp, 350/700-rpm, 600-volt d-c motor through a pinion stand. It is supported by a 1000-kw, 600-volt, d-c generator. The delivery reel is driven by a double-armature, 1600-hp, 214/770-rpm, 750-volt d-c motor. Each armature is rated 800-hp, 375-volt; and they are placed in series with a 1280-kw, 750 volt d-c generator. A series connection is employed to eliminate the use of a load balance regulator and to simplify the control circuit.

Figure 4 — This 21 and 25 x 60-in. sheet temper mill is used to illustrate how electrical equipment is selected for temper mills.

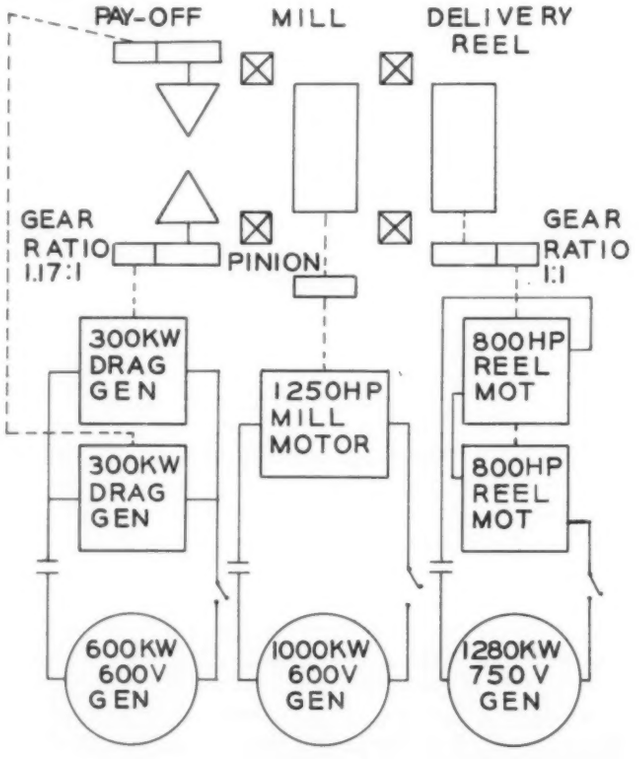


TABLE I
Data From Similar Mills

Mill	Strip size width x gage, in.	Back tension, psi	Front tension, psi
Mill A			
Test 1	36 1/8 x 0.0360	3480	5460
Test 2	31 5/8 x 0.0350	4100	8140
Test 3	31 5/8 x 0.0350	3510	8750
Test 4	31 5/8 x 0.0350	3250	5600
Mill B			
Test 1	51 3/4 x 0.0360	1560	5260
Test 2	51 3/4 x 0.0360	1685	3280
Mill C			
Test 1	51 1/16 x 0.0374	3980	6950
Test 2	61 3/4 x 0.0350	6130	6730
Test 3	71 3/4 x 0.0350	5000	6080
Test 4	69 3/4 x 0.0350	4850	6200
Mill D			
Test 1	26 1/2 x 0.0164	5050	9670
Test 2	49 1/2 x 0.0299	3050	5030
Test 3	29 1/2 x 0.0155	6880	7250
Test 4	29 1/2 x 0.0155	5280	4670
Test 5	49 1/2 x 0.0359	2010	6080
Test 6	49 1/2 x 0.0359	1715	5520
Average		3846	6604

Test data of front and back tension is shown in Table I which is used as a guide for selecting tensions. To provide sufficient tension capacity on a new mill values of 5000-psi back tension and 8000-psi front tension were selected for most of the products to be rolled. These values are reduced to 2000 psi and 3200 psi respectively for the heavier product as they are generally softer. To determine the amount of field range required by the reel motors, an inside diameter of 20 in. was used on both the entry and delivery reels. The maximum outside diameter for each schedule was then calculated except for the 0.020-in. thick by 30-in. wide strip where it was assumed a 72-in. outside diameter would be the maximum. The maximum outside diameter of a 40,000-lb coil of 0.035-in. thick by 48-in. wide steel would be 65 in., and the 0.080-in. thick by 54-in. wide steel would be 62 in. outside diameter. It was assumed the entry and delivery speed of the strip would be the same because so little extension is made. The maximum field range for coil diameter change is then 3.6:1.

Inertia values of the mechanical parts of the mill are based on figures known for similar mills. Values of 2050 lb-ft^2 at the motor shaft for both cones on the entry reel, 46,000 lb-ft^2 at the motor shaft for the mill, and 7700 lb-ft^2 at the motor shaft for the delivery reel were used.

Figure 5 — This mill friction curve in equivalent pounds of pull is based on tests made on a similar sheet temper mill.

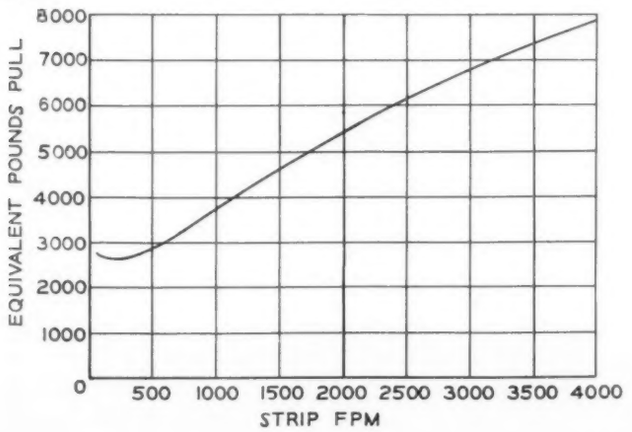


TABLE II
Test Data and Installed Capacity of Sheet Temper Mills

Mill	Test data Hp per in. width per 100 fpm	Installed capacity Hp per in. width per 100 fpm
Mill A—56 in.		0.715
Test 1	0.218	
Test 2	0.215	
Test 3	0.227	
Test 4	0.0	
Mill B—56 in.		0.308
Test 1	0.478	
Test 2	0.060	
Mill C—56 in.		0.595
Test 1	0.472	
Test 2	0.344	
Test 3	0.398	
Test 4	0.382	
Mill D—56 in.		0.618
Test 1	0.529	
Test 2	0.04	
Test 3	0.358	
Test 4	0.355	
Test 5	0.0	
Test 6	0.173	
Mill E—66 in.		1.06
Mill F—60 in.		0.505
Mill G—72 in.		0.556
Mill H—54 in.		0.74
Mill I—54 in.		0.685
Mill J—66 in.		0.505
Mill K—80 in.		0.43
Average	0.304	0.61

An indication of mill production that can be expected for each schedule is given. The delay time for the average 8-hr turn on a sheet temper mill ranges between 20 and 25 per cent. An average of 22 per cent is used in this calculation. Production is given by the formula:

$$\text{Production (net tons per hr)} = \frac{\text{Strip Cross-Sectional Area (sq in.)} \times \text{Strip Speed (fpm)}}{9.78 \times 1.22} \quad (1)$$

MILL STAND POWER

The mill stand motor power is then determined. The power required of the motor is influenced by four factors.

The first of these factors is the friction losses of the mill. Mill friction can be treated as equivalent back tension which the mill stand motor must pull against. Figure 5 is a plot of mill friction in equivalent pounds pull of back tension vs mill speed. This data was obtained from tests made on sheet temper mills similar to the mill being discussed.

The second factor to be determined for the mill stand power is the actual work on the strip. This is generally expressed as hp per in. of strip width per 100 fpm. Test data from several mills is shown in Table II. Also shown is a list of values for installations based on mill widths. It indicates acceleration requirements and mill friction are important factors in the final selection of the mill stand motor. For new mills a value of 0.4 hp per in. strip width per 100 fpm is used. The work horsepower for each schedule is then determined by the formula:

$$\text{Strip Work Power (hp)} = \frac{0.4 \times \text{Strip Width (in.)} \times \text{Strip Speed (fpm)}}{100} \quad (2)$$

The third consideration in the selection of mill stand power is the influence of front and back tension. The tension values (in psi) as previously given are converted to pounds pull for each schedule. The friction and tension horsepower, or equivalent tension horsepower, required is given by the formula:

$$\text{Total Equivalent Tension On Stand Motor (hp)} = \frac{[\text{Strip tension}_{back}\ (\text{lb}) + \text{Mill friction (lb)} - \text{Strip tension}_{front}\ (\text{lb})] \times \text{Strip speed (fpm)}}{33{,}000} \quad (3)$$

The work horsepower and equivalent tension horsepower are then added algebraically and divided by the rated horsepower of the motor to express the results in per cent.

$$\text{Total Rolling Power (per cent of motor rating)} = \frac{[\text{Strip Work (hp)} + \text{Total Equivalent Tension (hp)}]}{\text{Rating of Motor (hp)}} \times 100 \quad (4)$$

The fourth factor influencing the mill motor selection is acceleration. The rate of acceleration generally used to keep an economical design is 250 fpm per sec. The acceleration time for each schedule is then 16 sec to 4000 fpm; 14 sec to 3500 fpm; and 8 sec to 2000 fpm. The horsepower to accelerate the mill for each schedule is then calculated by using the formula:

$$\text{Acceleration (hp)} = \frac{\text{Inertia @ Motor Shaft (WK}^2) \times \text{Motor Speed}^2\ (\text{rpm})^2}{1.615 \times 10^6 \times \text{Acceleration Time (sec)} \times \text{efficiency}} \quad (5)$$

The selection of the mechanical arrangement of the drive can now be determined. As expected, the largest load imposed on the motor is during the rolling of the 0.020-in. thick x 30-in. wide product at 4000 fpm. A single armature motor rated 1250 hp or a twin drive arrangement using two 600-hp motors could be used. The inertia of the twin drive motors is approximately 50 per cent of the single armature motors. However, when considering the total inertia the single armature adds only 12.3 per cent. The total acceleration and work load on the single armature motor is 200 per cent. The total load on the twin drive unit is 101.2 per cent hp_{roll} and 94.2 per cent $hp_{accelerating}$ or 195.4 per cent total horsepower. In each instance motors with special overload capacities are required. The generator for support would be the same. The twin drive arrangement requires more control equipment by having two motors in parallel and provision for load balancing. As mentioned before, an offset pinion stand would also be required when using a twin drive arrangement. The single armature arrangement has an economic advantage of perhaps 5 per cent saving on the total cost of the electrical equipment. The possibility of using work rolls of unequal diameters is an advantage of the twin drive arrangement.

One further step is used in checking the motor selection for the mill stand. The root-mean-square heating on the drive motor is checked when the loading appears to be critical as in the case of the 0.020-in. thick x 30-in. wide product. This is done by taking the square root of the quotient of the sum of the hp^2-times-minutes over an average load cycle and the total cycle minutes. Figure 6 is a typical load curve for a motor. The percentage values of the loads with respect to the motor horsepower are used to obtain the root-mean-square per cent value in the following equation:

$$\text{RMS Horsepower (Per cent of motor rating)} = \sqrt{\frac{(hp_{acc} + hp_{roll})^2 \times T_{acc} + hp^2_{roll} \times T_{roll} + (hp_{roll}\text{-}hp_{dec})^2 \times T_{dec}}{T_{total}}} \quad (6)$$

REEL POWER

The entry reel power requirement is then calculated. The drag generator capacity required for the tensions given previously are determined for each schedule by the formula:

$$\text{Tension Power (kw)} = \frac{\text{Tension (lb)} \times \text{Strip Speed (fpm)}}{33{,}000 \times \text{Generator Efficiency} \times 0.746} \quad (7)$$

These values are then multiplied by the ratio of top mill speed to operating mill speed to obtain the heating load on the drag generators when the line is operated at top speed. The final results are expressed in per cent of rated load. The speed range of the drag generators is obtained from the coil diameter range which is 3.6:1. The top mill speed sets the maximum speed of the cone type mandrels. Top mill speed results when the maximum diameter work roll is used with weak field of the stand motor. In this example, top mill speed would be 4030 fpm. When a 20-in. diam mandrel is used, the required speed of the cone type mandrel is 770 rpm. A gear ratio of 1.17:1 allows the selection of a 250/900-rpm speed range for the drag generators. The deceleration kw for each schedule is given by formula (5) except that the machine losses now aid in stopping. The deceleration kilowatts are checked for several different coil diameters to find the maximum value. The result is then given as per cent rated load after it is converted to equivalent heating kilowatts. The root-mean-square heating load is then checked as was done on the mill stand with equation (6).

The same procedure is used for the delivery reel as is

Figure 6 — This is a typical load cycle for a mill drive motor of a sheet temper mill. From it, the root-mean-square heating in horsepower can be calculated for the motor.

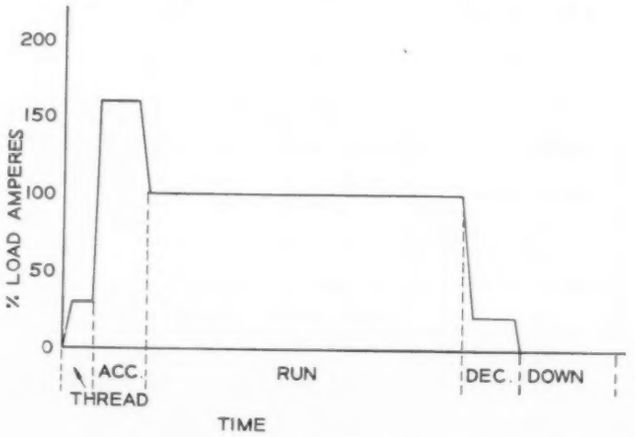


TABLE III
Summary of Power Requirement Calculations

Schedule	Net tons per hr	Reel tension		Entry reel	Mill stand (per cent of motor rating)	Delivery reel (per cent of motor rating)
		Entry reel	Delivery reel			
(1) 0.02 x 30 in.	200.5	5000	8000			
Acc. load, per cent				7.6	200.0	101.6
Run load, per cent				41.1	97.0	40.7
Dec. load, per cent				80.1	6.0	17.0
RMS heating, per cent				...	97.7	...
(2) 0.035 x 48 in.	528.0	5000	8000			
Acc. load, per cent				82.6	163.5	173.0
Run load, per cent				114.0	73.4	113.0
Dec. load, per cent				142.0	16.7	83.0
RMS heating, per cent				103.7	...	106.4
(3) 0.08 x 54 in.	725.0	2000	3200			
Acc. load, per cent				73.5	87.7	176.8
Run load, per cent				117.3	36.1	116.5
Dec. load, per cent				155.7	15.5	85.6
RMS heating, per cent				106.9	...	106.8

1. 4000 fpm requires 16 second acc elevating time
2. 3500 fpm requires 14 second acc elevating time
3. 2000 fpm requires 8 second acc elevating time

Rated hp	2-300 kw	1250 hp	1600 hp (DA)
Speed	250/900 rpm	350/700 rpm	214/770 rpm
Voltage	600	600	750

used for the entry reel. The same basic equation (7) is used. The mechanical and electrical losses in the drive now subtract from the reel and the horsepower must be increased by dividing by the efficiency.

The same calculations for accelerating loads are made for each schedule and different coil diameters as for the entry reels. The root-mean-square heating loads are checked when rolling the heavier schedules.

DESIGN FEATURES OF MOTORS

A summary of the calculations made for each schedule is given in Table III. The values are given in per cent of rated load with the machine ratings appearing at the bottom. It simplifies the calculation procedure to use percentage values throughout.

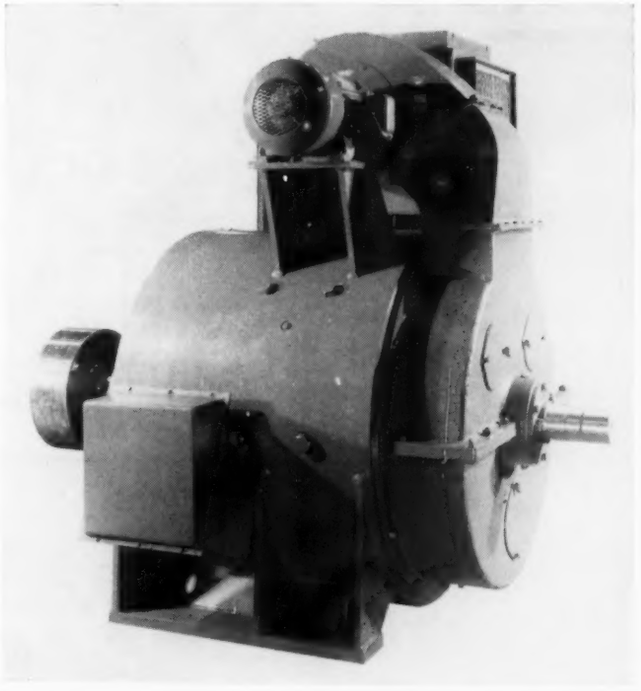
As higher mill speeds require more horsepower the use of common bus systems with booster generators for a sheet temper mill becomes uneconomical. Booster generators are essentially high current machines which require more than the usual amount of maintenance. For these reasons an individual generator system is more economically applied to the modern sheet temper mill. The generators are usually Class A insulated, 40 C rise machines. Forced ventilation is normal because of the location, although open self ventilated generators can be used in motor rooms.

The drag generators are normally Class B insulated, 60 C-rise machines to reduce their inertia. Forced ventilation by means of a "piggy back" blower is used because they are required to move to center the coil in the mill and also to enter a coil when cones are used. End shield type anti-friction bearings are also used for this reason. A typical machine is shown in Figure 7.

The mill stand motor would have special overload ratings for 200 per cent frequently applied momentary loads, which occur during acceleration when rolling the lighter sheet product. A 250 per cent occasionally applied momentary load capability is inherent with this design. It aids in reducing the emergency stopping time. The normal design would be Class B insulation, 40 C rise with pedestal bearings and forced ventilating covers. If a thrust bearing is not provided with the mechanical equipment, it is necessary on the motor to protect against axial shock loads from the mill.

The delivery reel motor is of special design electrically. Special load capacity, similar to that of the mill stand, is required as acceleration is done at the weak field setting of the motor. The special speed range is employed to eliminate the use of a speed increaser

Figure 7 — The drag generators have "piggy back" blowers so that sufficient motor ventilation is maintained at motors speeds under base speed.



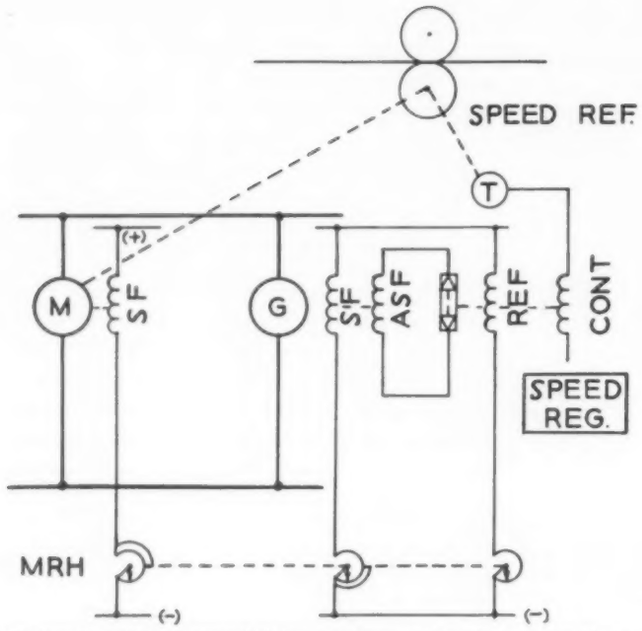


Figure 8 — Large stand drive motors, with their large time constants, require a speed regulator scheme.

which would be required in using a lower speed motor. Both the lower speed motor and gear ratio increase would create additional accelerating problems. The drive would have the standard three pedestal bearing, double armature arrangement with Class B insulation, 60 C rise machines with covers for forced ventilation. A 375-volt armature is used to reduce the length of the commutator and the number of brushes as much as possible and still use a series connection to simplify the control circuitry.

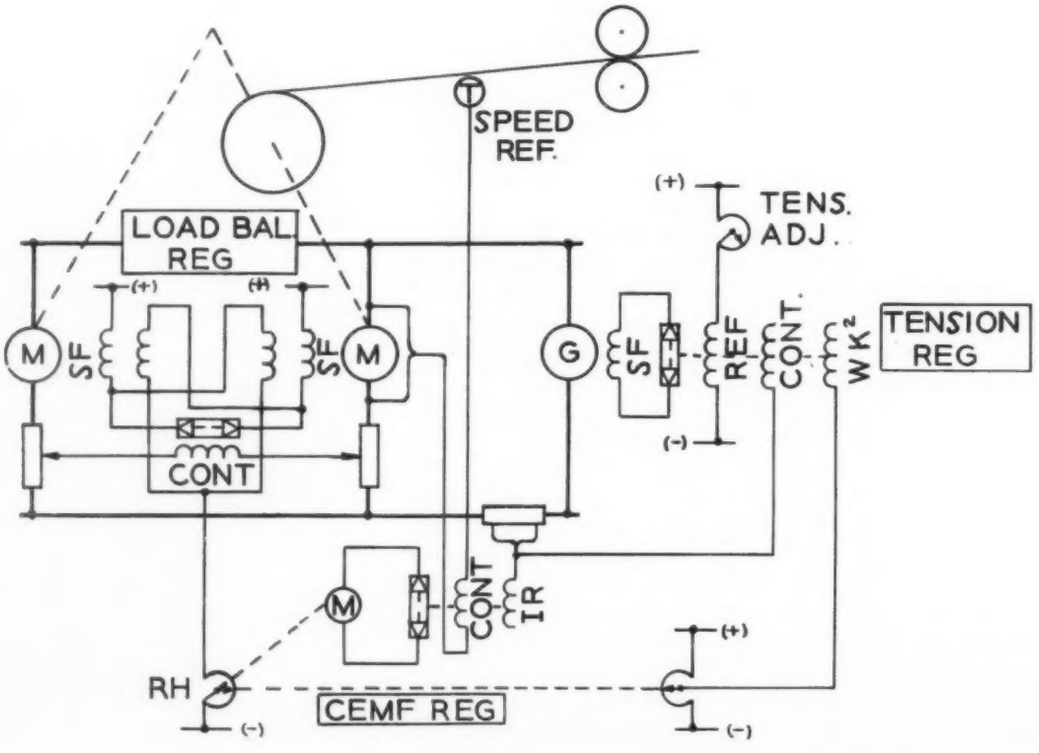
CONTROL

The stand control for higher speed mills involving larger machines requires a close examination. With machines of small ratings and time constants, the use of preset motor field and accelerating on generator voltage appears to be the most practical method without the use of regulators. Breakaway torque is easily obtained by forcing the motor field momentarily at the start.

When larger machines with greater time constants are used, a speed regulator scheme should be examined. Figure 8 is the simplified schematic using a speed regulator. A signal from the mill pilot tachometer, which is balanced against a signal from the main rheostat, forces the generator output to maintain the speed change set by the main rheostat. This results in the smooth acceleration curve desired.

The control of reel tension is obtained by using the standard scheme of two regulators. One regulator controls loop current, and the other controls the counter emf of the drive motor by changing its field to match coil diameter change. The use of a series connection on the delivery reel and cross connecting the north and south poles of the main fields of the motors permits the use of one counter-emf regulator and does not require a load balance regulator. When using a cone type entry reel, a parallel connection is desirable to reduce the possibility of overspeed by overvoltage should one of the cones slip during the rolling of a coil. With a parallel connection of the armatures a load balance regulator is desirable to assure even load distribution. Figure 9 is a simplified schematic diagram showing the standard reel control with a load balance regulator used. The north and south poles of alternate machines are connected through the load balance regulator in a bridge circuit. A measure of differential current in each machine armature is used to signal the regulator. Any unbalance in armature current causes the regulator to change the field to bring the system back into balance. The signal of strip speed for the tension regulating system is obtained from tachometers mounted on the billy rolls on either side of the mill. The greater use of the extensometer on temper

Figure 9 — Schematic of a standard reel control with a load balance regulator.



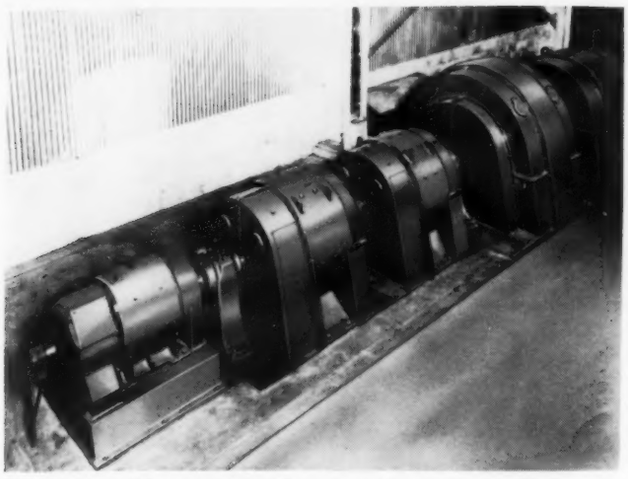


Figure 10 — The expense of a separate motor room can be eliminated by placing the control in the basement which is kept pressurized, and putting the machinery, such as this motor-generator set, on the mill floor.

mills requires that the billy rolls be used. They also provide a means of obtaining actual strip speed, which improves the accuracy of the tension control.

The regulators shown in both Figures 8 and 9 are comprised of 60-cycle, push-pull magnetic amplifiers, which are used as the preamplification stage, and a standard or laminated yoke d-c exciter for the second stage. The response time and sensitivity of a regulator comprised of these components is satisfactory for a sheet temper mill application.

Ventilating systems are generally divided into the nonrecirculating and recirculating type. The type selected usually depends on climatic conditions. It is possible to eliminate the expense of a separate motor room with either type by placing the control equipment in the basement which is kept under pressure, and leave the machines on the mill floor. Figure 10 is an example of such an installation showing the motor-generator set on the mill floor.

In conclusion, future sheet temper mills will follow the established trend to higher speeds requiring more power. Larger coils of better shape and quality will tend to reduce the need for tension pullers. It is hoped the use of the procedure outlined for the selection of mill electrical equipment will serve as a guide for future mills, but more data and closer examination of the metallurgical aspects of sheet tempering must be constantly considered. The summary of calculations shown in Table III indicates that the loading for all gages to be rolled must be considered carefully to obtain the proper power selection. The use of the extensometer to regulate elongation by a combination of roll pressure and tension for future mills should also be considered.

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APPENDIX

A. MILL STAND POWER

Work Horsepower, equation (2)

(*a*) 0.02 x 30 in. product $= \dfrac{0.4 \times 30 \times 4000}{100} = 480$ hp

(*b*) 0.035 x 48-in. product $= \dfrac{0.4 \times 48 \times 3500}{100} = 671$ hp

(*c*) 0.08 x 54-in. product $= \dfrac{0.4 \times 54 \times 2000}{100} = 432$ hp

Equivalent Tension Horsepower, equation (3)

(*a*) 0.02 x 30-in. product = 0.6 sq in. x 5000 psi = 3,000 lb = $\text{tension}_{\text{back}}$

At 4000 fpm = 7,650 lb = $\text{tension}_{\text{friction}}$

10,650 lb = total drag

0.6 sq in. × 8000 psi = −4,800 lb = $\text{tension}_{\text{front}}$

6,050 lb = tension drag (net)

$$\text{Equ. Tension} = \frac{6050 \text{ lb} \times 4000 \text{ fpm}}{33{,}000} = 734 \text{ hp}_{\text{equ. tension}}$$

(*b*) 0.035 x 48-in. product = 1.68 sq in. x 5000 psi = 8,400 lb = $\text{tension}_{\text{back}}$

At 3500 fpm = 7,400 lb = $\text{tension}_{\text{friction}}$

15,800 lb = total drag

1.68 sq in. x 8000 psi = −13,480 lb = $\text{tension}_{\text{front}}$

2,320 lb = tension drag (net)

$$\text{Equ. Tension} = \frac{2320 \text{ lb} \times 3500 \text{ fpm}}{33{,}000} = 246 \text{ hp}_{\text{equ. tension}}$$

(*c*) 0.08 x 54-in. product = 4.32 sq in. x 2000 psi = 8,640 lb = $\text{tension}_{\text{back}}$
At 2000 fpm = 5,500 lb = $\text{tension}_{\text{friction}}$
14,140 lb = total drag
4.32 sq in. x 3200 psi = −13,820 lb = $\text{tension}_{\text{front}}$
320 lb = tension drag (net)

$$\text{Equ. Tension} = \frac{320 \text{ lb} \times 2000 \text{ fpm}}{33{,}000} = 19.4 \text{ hp}_{\text{equ. tension}}$$

Total Roll Horsepower

(*a*) 0.02 x 30-in. product, 480 hp_{work} + 734 $\text{hp}_{\text{equ. tension}}$ = 1214 hp_{roll}
(*b*) 0.035 x 48-in. product, 671 hp_{work} + 246 $\text{hp}_{\text{equ. tension}}$ = 917 hp_{roll}
(*c*) 0.08 x 54-in. product, 432 hp_{work} + 19.4 $\text{hp}_{\text{equ. tension}}$ = 451.4 hp_{roll}

Total Roll Horsepower As Per Cent Of Rated Horsepower, equation (4)

Hp_{roll} per cent	1250-hp drive	1200-hp drive
(*a*) 0.02 x 30-in. product	97	101.2
(*b*) 0.035 x 48-in. product	73.4	76.5
(*c*) 0.08 x 54-in. product	36.1	37.6

Acceleration Horsepower: 1250-hp single armature, equation (5)

4000 fpm = 700 rpm, 3500 fpm = 612 rpm, 2000 fpm = 350 rpm
$\text{WK}^2_{\text{mill}} + \text{WK}^2_{\text{moter}} = 46{,}000 + 15{,}200 = 61{,}200$ lb-ft^2

(*a*) 0.02 x 30-in. product, $\text{hp}_{\text{Acc.}} = \dfrac{61{,}200 \times 700^2}{1.615 \times 10^6 \times 16 \times 0.9} = 1290$ hp = 103 per cent load

(*b*) 0.035 x 48-in. product, $\text{hp}_{\text{Acc.}} = \dfrac{61{,}200 \times 612^2}{1.615 \times 10^6 \times 14 \times 0.9} = 1125$ hp = 90.0 per cent load

(*c*) 0.08 x 54-in. product, $\text{hp}_{\text{Acc.}} = \dfrac{61{,}200 \times 350^2}{1.615 \times 10^6 \times 8 \times 0.9} = 645$ hp = 51.6 per cent load

Acceleration Horsepower: 2–600-hp twin drive, equation (5)

$\text{WK}^2_{\text{mill}} + \text{WK}^2_{\text{motor}} = 4600 + 7660 = 53{,}660$ lb-ft^2

(*a*) 0.02 x 30-in. product, $\text{hp}_{\text{Acc.}} = \dfrac{53{,}660 \times 700^2}{1.615 \times 10^6 \times 16 \times 0.9} = 1130$ hp = 94.2 per cent load

(*b*) 0.035 x 48-in. product, $\text{hp}_{\text{Acc.}} = \dfrac{53{,}660 \times 612^2}{1.615 \times 10^6 \times 14 \times 0.9} = 986$ hp = 82.3 per cent load

(*c*) 0.08 x 54-in. product, $\text{hp}_{\text{Acc.}} = \dfrac{53{,}660 \times 350^2}{1.615 \times 10^6 \times 8 \times 0.9} = 565$ hp = 47.1 per cent load

Total Motor Load When Line Is Accelerating (Per Cent of Rated Load)

	1250 hp	*1200 hp*
0.02 x 30-in. product	200.0	195.4
0.035 x 48-in. product	163.5	158.8
0.08 x 54-in. product	87.7	84.7

(*a*) *Root-Mean-Square Heating Mill Stand*, 0.02 x 30-in. product and 1250-hp motor, equation (6)

Length of mean turn in 72-in. coil = 12.05 ft
Number of wraps = 1238 total ft = 12.05 x 1238 = 14,930 ft
14,930 ft ÷ 4000 fpm = 3.74 min to roll; total time = 4.57 min

$$\text{RMS}_{\text{heat}} \sqrt{\frac{2.0^2 \times \frac{16}{60} + 0.97^2 \times 3.21 + 1.03^2 \times \frac{16}{60}}{4.57}} = 97.68 \text{ per cent load (based on 1250-hp motor)}$$

B. ENTRY REEL POWER REQUIREMENTS: TWO 300-KW DRAG GENERATORS

(*a*) *0.02 x 30-in. product—4000 fpm*

$$\text{Kw}_{\text{Tension}} = \frac{0.6 \text{ sq in.} \times 5000 \text{ psi} \times 4000 \text{ fpm}}{33{,}000} \times 0.9 \times 0.746 = 246.5, \text{ equation (7)}$$

$$\frac{246.5 \text{ kw}}{600 \text{ kw}} = 41.1 \text{ per cent load}$$

$$WK^2_{cones} + WK^2_{drags} = \frac{2800}{1.17^2} + 9040 = 11{,}085 \text{ lb-ft}^2$$

$$WK^2_{72\text{-in. coil and cones}} + WK^2_{drags} = \frac{156{,}800}{1.17^2} + 9040 = 123{,}240 \text{ lb-ft}^2$$

$$Kw_{Acc.} = \frac{123{,}240 \times 250^2 \times 0.9 \times 0.746}{1.615 \times 10^6 \times 16} = 202 \text{ kw}$$

$$\frac{202 \text{ kw}}{600 \text{ kw}} = 33.5 \text{ per cent load}$$

$$Kw_{Dec.} = \frac{11{,}085 \times 900^2 \times 0.746}{1.615 \times 10^6 \times 16 \times 0.9} = 233.51 \text{ kw}$$

$$\frac{233.51 \text{ kw}}{600 \text{ kw}} = 39 \text{ per cent load}$$

$Kw_{Total\ Acc.} = 41.1 - 33.5 = 7.6$ per cent

$Kw_{Total\ Dec.} = 41.1 + 39 = 80.1$ per cent load

(*b*) *0.035 x 48-in. product—3500 fpm*

$$Kw_{Tension} = \frac{1.68 \text{ sq in.} \times 5000 \text{ psi} \times 3500 \text{ fpm}}{33{,}000} \times 0.9 \times 0.746 = 598 \text{ kw, equation (7)}$$

$$598 \times \frac{4000}{3500} = 682 \text{ kw}$$

$$\frac{682 \text{ kw}}{600 \text{ kw}} = 114 \text{ per cent load}$$

$$WK^2_{65\text{-in. coil and cones}} + WK^2_{drags} = \frac{166{,}100}{1.17^2} + 9040 = 130{,}240 \text{ lb-ft}^2$$

$$Kw_{Acc.} = \frac{130{,}240 \times 206^2}{1.615 \times 10^6 \times 14} \times 0.9 \times 0.746 = 164.5 \text{ kw}$$

$$\frac{4000}{3500} \times 164.5 \text{ kw} = 188 \text{ kw}$$

$$\frac{188 \text{ kw}}{600 \text{ kw}} = 31.4 \text{ per cent load}$$

$$Kw_{Dec.} = \frac{11{,}085 \times 670^2}{1.615 \times 10^6 \times 14} \times 0.9 \times 0.746 = 147.5 \text{ kw}$$

$$\frac{4000}{3500} \times 147.5 \text{ kw} = 168.5 \text{ kw}$$

$$\frac{168.5 \text{ kw}}{600 \text{ kw}} = 28 \text{ per cent load}$$

$Kw_{Total\ Acc.} = 114 - 31.4 = 82.6$ per cent load

$Kw_{Total\ Dec.} = 114 + 28 = 142$ per cent load

Length of Mean Turn 65-in. coil = 11.15 ft, No. of wraps = 625, total length = 6980 ft
Time roll = 6980 ft ÷ 3500 fpm = 1.99 min; total time = 3.0 min

$$RMS_{heat} = \sqrt{\frac{0.826^2 \times \frac{14}{60} + 1.14^2 \times 1.99 + 1.42^2 \times \frac{14}{60}}{3.0}} = 103.68 \text{ per cent load}$$

(*c*) *0.08 x 54-in. product*

$$Kw_{Tension} = \frac{4.32 \text{ sq in.} \times 2000 \text{ psi} \times 2000 \text{ fpm}}{33{,}000} \times 0.9 \times 0.746 = 352 \text{ kw}$$

$$\frac{4000}{2000} \times 352 \text{ kw} = 704 \text{ kw}$$

$$\frac{704 \text{ kw}}{600 \text{ kw}} = 117.3 \text{ per cent load}$$

$$WK^2_{62\text{-in. coils + cones}} + WK^2_{\text{drags}} = \frac{154{,}900}{1.17^2} + 9040 = 122{,}040 \text{ lb-ft}^2$$

$$Kw_{Acc.} = \frac{122{,}040 \times 144^2}{1.615 \times 10^6 \times 8} \times 0.9 \times 0.746 = 131.51 \text{ kw}$$

$$\frac{4000}{2000} \times 131.5 = 263 \text{ kw}$$

$$\frac{263 \text{ kw}}{600 \text{ kw}} = 43.8 \text{ per cent load}$$

$$Kw_{Dec.} = \frac{11{,}085 \times 447^2}{1.615 \times 10^6 \times 8} \times 0.9 \times 0.746 = 115.1 \text{ kw}$$

$$\frac{4000}{2000} \times 115.1 \text{ kw} = 230 \text{ kw}$$

$$\frac{230 \text{ kw}}{600 \text{ kw}} = 38.4 \text{ per cent load}$$

$$Kw_{\text{Total Acc.}} = 117.3 - 43.8 = 73.5 \text{ per cent load}$$

$$Kw_{\text{Total Dec.}} = 117.3 + 38.4 = 155.7 \text{ per cent load}$$

Length of Mean Turn 62-in. coil = 10.72 ft, No. of wraps = 259, total length = 2780 ft
Time roll = 2780 ft ÷ 2000 fpm = 1.39 min, total time = 2.03 min

$$RMS_{heat} = \sqrt{\frac{0.735^2 \times \frac{8}{60} + 1.173^2 \times 1.39 + 1.557^2 \times \frac{8}{60}}{2.03}} = 106.88 \text{ per cent load}$$

C. DELIVERY REEL POWER REEL REQUIREMENTS—1600-HP MOTOR

(a) 0.02 x 30-in. product—4000 fpm

$$Hp_{Tension} = \frac{0.6 \text{ sq in.} \times 8000 \text{ psi} \times 4000 \text{ fpm}}{33{,}000 \times 0.9} = 652 \text{ hp}$$

$$\frac{652 \text{ hp}}{1600 \text{ hp}} = 40.7 \text{ per cent load}$$

$$WK^2_{\text{mandrel}} + WK^2_{\text{motors}} = 7{,}700 + 30{,}400 = 38{,}100 \text{ lb-ft}^2$$

$$Hp_{Dec.} = \frac{192{,}100 \times 214^2}{1.615 \times 10^6 \times 0.9} = 379$$

$$\frac{379}{1600} = 23.7 \text{ per cent load}$$

$$Hp_{Acc.} = \frac{38{,}100 \times 770^2}{1.615 \times 10^6 \times 16 \times 0.9} = 973 \text{ hp}$$

$$\frac{973 \text{ hp}}{1600 \text{ hp}} = 60.9 \text{ per cent load}$$

$$Hp_{\text{Total Acc.}} = 40.7 + 60.9 = 101.6 \text{ per cent load}$$

$$Hp_{\text{Total Dec.}} = 40.7 - 23.7 = 17.0 \text{ per cent load}$$

(b) 0.035 x 48-in. product—3500 fpm

$$Hp_{Tension} = \frac{1.68 \text{ sq in.} \times 8000 \text{ psi} \times 3500 \text{ fpm}}{33{,}000 \times 0.9} = 1585 \text{ hp}$$

$$\frac{4000}{3500} \times 1585 \text{ hp} = 1810 \text{ hp}$$

$$\frac{1810 \text{ hp}}{1600 \text{ hp}} = 113.0 \text{ per cent load}$$

$$WK^2_{65\text{-in. coil and mandrel}} + WK^2_{\text{motor}} = 171{,}000 + 30{,}400 = 201{,}400 \text{ lb-ft}^2$$

$$Hp_{Dec.} = \frac{201{,}400 \times 206^2}{1.615 \times 10^6 \times 14 \times 0.9} = 420 \text{ hp}$$

$$\frac{4000}{3500} \times 420 \text{ hp} = 481 \text{ hp}$$

$$\frac{481 \text{ hp}}{1600 \text{ hp}} = 30 \text{ per cent load}$$

$$Hp_{Acc.} = \frac{38{,}100 \times 670^2}{1.615 \times 10^6 \times 14 \times 0.9} = 842 \text{ hp}$$

$$\frac{4000}{3500} \times 842 \text{ hp} = 961 \text{ hp}$$

$$\frac{961 \text{ hp}}{1600 \text{ hp}} = 60 \text{ per cent load}$$

$$Hp_{\text{Total Acc.}} = 113.0 + 60.6 = 173.0 \text{ per cent load}$$

$$Hp_{\text{Total Dec.}} = 113.0 - 30.0 = 83.0 \text{ per cent load}$$

$$RMS_{heat} = \sqrt{\frac{1.73^2 \times \frac{14}{60} + 1.132^2 \times 1.99 + 0.83^2 \times \frac{14}{60}}{3.0}} = 106.42 \text{ per cent load}$$

(*c*) *0.08 x 54-in. product—2000 fpm*

$$Hp_{Tension} = \frac{4.3259 \text{ sq in.} \times 3200 \text{ psi} \times 2000 \text{ fpm}}{33{,}000 \times 0.9} = 932 \text{ hp}$$

$$\frac{4000}{2000} \times 932 \text{ hp} = 1864 \text{ hp}$$

$$\frac{1864 \text{ hp}}{1600 \text{ hp}} = 116.5 \text{ per cent load}$$

$$WK^2_{62\text{-in. coil and mandrel}} + WK^2_{\text{motor}} = 159{,}600 + 30{,}400 = 190{,}000 \text{ lb-ft}^2$$

$$Hp_{Dec.} = \frac{190{,}000 \times 123^2}{1.615 \times 10^6 \times 8 \times 0.9} = 247 \text{ hp}$$

$$\frac{4000}{2000} \times 247 \text{ hp} = 494 \text{ hp}$$

$$\frac{494 \text{ hp}}{1600 \text{ hp}} = 30.9 \text{ per cent load}$$

$$Hp_{Acc.} = \frac{38{,}100 \times 382^2}{1.615 \times 10^6 \times 8 \times 0.9} = 478 \text{ hp}$$

$$\frac{4000}{2000} \times 478 \text{ hp} = 956 \text{ hp}$$

$$\frac{956 \text{ hp}}{1600 \text{ hp}} = 60.3 \text{ per cent load}$$

$$Hp_{\text{Total Acc.}} = 116.5 + 60.3 = 176.8 \text{ per cent load}$$

$$Hp_{\text{Total Dec.}} = 116.5 - 30.9 = 85.6 \text{ per cent load}$$

$$RMS_{heat} = \sqrt{\frac{1.768^2 \times \frac{8}{60} + 1.165^2 \times 1.39 + 0.856^2 \times \frac{8}{60}}{2.03}} = 106.8 \text{ per cent load}$$

Discussion

PRESENTED BY

A. F. KENYON, Advisory Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

W. E. Miller, Manager, Metal Rolling & Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

R. M. PEEPLES, Supervisory Engineer, Metal Working Control Section, Control Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

D. E. REA, Application Engineer, Electrical Application Dept., Industrial Equipment Div., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

A. F. Kenyon: The test data given in Tables I and II illustrate the difference in operating practice of different mills, also the variations on individual mills to properly process strip of different width, thickness and condition. In Table I it is noted that the observed back tension varied from 1560 to 6880 psi and front tension varied from 4670 to 9670 psi. In general the higher psi values were used for the lighter gage strip although on mill "C" rolling heavy gage strip the front and back unit tensions were both quite high. On mill "A", also rolling heavy gage strip, the front unit tension was quite high; and the unit back tension was more moderate.

Also in Table II observed net mill rolling load tests showed variations from a low of practically 0 to a maximum of 0.529 hp per in. of strip width per 100-fpm strip speed. If I interpret the author's data correctly, the data shown in the second column of Table II is the actual net mill work after making allowances for mill friction and front and back tensions. I am curious how some of these values can be so low if any work is being done on the strip. The author's further comments will be appreciated to clarify this seeming inconsistency.

In discussions of earlier papers dealing with temper pass mill drives I have commented on the usual large acceleration load on the mill stand motor resulting from the large inertias of the mill backing rolls and the relatively small stand motor rating. In most cases the rating of the stand drive motor should be determined by the acceleration torque requirement, and by the breakaway starting torque requirement, and with the drive selected to provide satisfactory starting and acceleration performance, the running load usually will be well within the motor rating and the root-mean-square heating load need not be considered. As indicated by the author it frequently will be economical to select the mill stand motor with special 250 per cent momentary load capacity to provide ample starting and acceleration capacity.

Many large temper pass mills are operating successfully with a common bus control system in which the mill stand motor, winding reel motor, and pay-off reel drag generator, all operate from a common power supply generator with a booster generator in each of the reel circuits. However, we agree that present usual practice is to employ a separate power supply generator for each mill, reel and tension puller drive. An advantage of the separate generator system is that in some cases it is economical and advantageous to make the different drives for different voltage ratings.

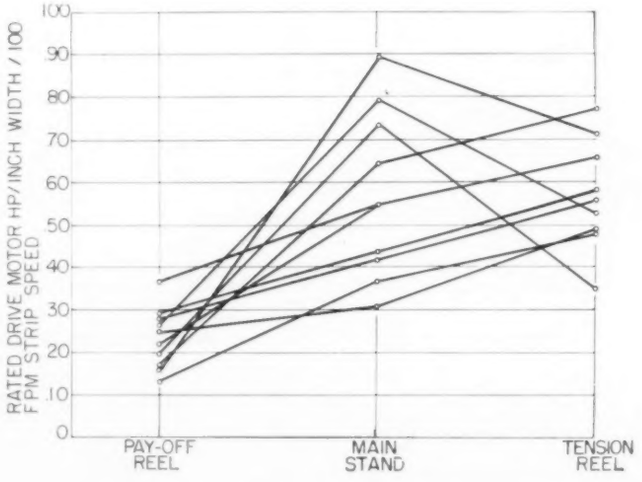
W. E. Miller: The power requirements for temper mills have never been as clearly defined as for other types of rolling mills. The usual practice has been to select drive ratings based more or less upon the drive ratings on existing similar mills. Considerable data has been published by the AISE as can be seen from the Bibliography of the paper. Reference 4 of the Bibliography, "Selection of Electrical Equipment for Temper and Skin Pass Mill" gives data (Figure 11) which shows that there are sheet mills in operation with main stand ratings varying between 0.31 to 0.89 hp per in. width per 100 fpm. This factor for the motor selected by Mr. Rea in his example is about 0.52. However, the significant thing is that for his example of 30-in. material being rolled at 4000 fpm his formulas indicate the work horsepower equal to 480 and the friction horsepower equal to 945.

In the discussion of the earlier papers it was pointed out that friction factors and work factors varied considerably between mills indicating that the mechanical design and mechanical structure has a great deal to do with the horsepower required. Possibly no other type of mill requires closer co-ordination between user, machinery manufacturer and electrical manufacturer in the selection of electric drive ratings.

The calculating methods outlined by the author are correct, but I believe that use should be made of more of the published data on a larger variety of existing mills before a final selection of drive ratings is made.

Considerable discussion could be devoted to the subject of regulating systems. I should like to mention only one point. When a stand speed regulator as shown in Figure 8 is used, the stand d-c motor and generator are subjected to transient overvoltage. The shorter the accelerating time the greater the overvoltage. Rating specifications are pretty well defined by the author except for this point. This is a factor that affects the selection of the type of regulating system, its design, its adjustment, and the design of the stand d-c motor and generator, or else it could limit the actual minimum accelerating time of the mill.

Figure 11 — Installed power for existing single stand temper mills.



R. M. Peeples: Regulating systems are subject to considerable discussion. Each system will have particular advantages which are not universally shared by all others. The ultimate choice between relatively comparable methods are then based on economics and many times, personal preference.

Probably the chief advantages of the system shown in the paper is the precise regulation of actual stand speed attained along with simplicity and a minimum of equipment. Both features are of interest to industrial engineering and maintenance personnel.

In designing the system it is of course primarily necessary to utilize machinery which is capable of carrying load with at least a small percentage of overvoltage occasionally. The only special attention necessary thereafter is in the design of the main drive motor field circuit. This circuit must be arranged with as low a time constant as practical for close tracking with the main rheostat.

Should the design of motor and generator be out on the limb so to speak, a certain amount of leeway is obtained by overlapping the motor field ring to start reducing motor flux prior to reaching full voltage. A minor reduction in flux is usually sufficient. When the drive being considered is in the category of the sheet temper mill, the main drive motor is seldom the bottle neck either in load used or in the accelerating current required. Therefore, it is practical and economical to consider simplification wherever possible.

All these factors can be pre-calculated, however, and should the situation be such that it is necessary to refine the system, a regulator is added to the motor field circuit which provides a forcing action to obtain closer tracking of motor field and rheostat. The regulated action can be in response to a motor field current signal or in response to the mill tachometer. In the latter case, a mill speed regulator is obtained utilizing the generator at low speeds and the motor flux at higher speeds.

D. E. Rea: In the earlier years of temper rolling it had never been a matter of investigation just how much of the mill power was doing friction work and how much was useful and how these factors varied with types of mill. Although the power measurements could never be extremely accurate, at least some order was made out of years of taking data. It has been found that similar tempers are being obtained by wide variations in effectiveness of the mill stand, in combination with similar variations in tensions being used. No doubt this condition will always be with us and must be considered in calculating motor horsepower for new sheet temper mills.

In answer to Mr. Kenyon's questions regarding Table II, the second column of figures are the actual installed ratings of several mill installations to illustrate the variance in the industry. ▲

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

No June Meeting

BUFFALO SECTION

Tuesday, June 2, 1959
Golf Party
Cherry Hill Country Club

CANTON SECTION

No June Meeting

CHICAGO SECTION

Tuesday, June 16, 1959
Golf Party
Gary Country Club, Gary, Ind.

CLEVELAND SECTION

Thursday, *July* 16, 1959
Golf Party
Elyria Country Club
Route U. S. 20 West of Elyria

DETROIT SECTION

Saturday, May 23, 1959
Summer Dinner & Dance
Detroit Yacht Club

LOS ANGELES SECTION

No June Meeting

PHILADELPHIA SECTION

No June Meeting

PITTSBURGH SECTION

Monday, June 1, 1959
Golf Party
Churchill Valley Country Club
Penn Hills, Pittsburgh, Pa.

ST. LOUIS SECTION

No June Meeting

SAN FRANCISCO SECTION

No June Meeting

UTAH SECTION

No June Meeting

YOUNGSTOWN SECTION

Thursday, June 18, 1959
Golf Party and Dinner
Trumbull Country Club, Warren, Ohio

Monolithic Refractory Constructions In Steel Plant Equipment

by George D. Cobaugh,
Manager,
Speciality Sales
and Charles R. Hauth,
Technical Sales,
Harbison-Walker Refractories Co.,
Pittsburgh, Pa.

Water-mix castables, shipped dry in sacks, can be either placed by an air gun, poured, or tamped . . . . most of them have negligible shrinkage in service, low coefficients of thermal expansion, and are resistant to spalling and abrasion . . . . panel construction with castables permits casting, curing and drying prior to actual start of maintenance or construction . . . . plastic fire brick, ordinarilly furnished as slabs having the proper workability, are particularly useful for patching and eliminating tedious bricklaying and the need for special shapes . . . . ramming mixtures, which can be shipped either wet or dry, are applicable to areas subjected to high temperatures.

THE steel industry, with its relatively high consumption of refractories, continues to be particularly interested in better refractory performance and more economical methods of installation and use. This applies to maintenance of existing furnaces and construction of new furnaces for the reduction of ore, refining of steel, heating ingots and billets, heat-treating and annealing operations. Blast furnace, coke oven, open hearth and rolling mill departments in co-operation with ceramic, fuel and combustion departments are closely following the experiences with various types of refractories in their respective furnaces.

Over the past ten years, monolithic refractories have been tried and found to offer a good solution to speedy maintenance and outstanding performance in new furnaces at service costs which are realistic and economical.

In this paper are covered some of the properties of the various monolithic refractories which the manufacturers of these products have developed. The application of this group of refractories is given in accompanying Table I. Some recent developments of monolithic refractories are discussed in detail.

CASTABLE REFRACTORIES

The monolithic refractories of this group are manufactured by blending specially sized aggregates of refractory materials and hydraulic setting binders in correct proportions for various applications. These products are shipped dry in sacks, and after having been mixed with water to the desired consistency are poured or tamped into place to form full monolithic structures and linings. A very widely used method for the installation of castables is by means of the air placement gun. Most castable refractories show negligible shrinkage in service, have a low coefficient of thermal expansion, and are resistant to both spalling and abrasion. There is a wide range of castables available to meet standard and special service requirements. Table II lists these various types with some characteristic densities and service limits.

There is a wide variety of castables ranging from the very light insulating castables to the heavy basic castables. Since the thermal conductivity of the lighter castables is lower than the heavier castables, they serve advantageously as thermal insulation. Where abrasion or slag action are not a factor, these lightweight castables may also be used for primary walls and linings.

Panel construction with castables is gaining favor due

TABLE I

Monolithic Refractory Applications In The Steel Industry

	CASTABLES						PLASTIC FIRE BRICK					RAMMING MIXES		GUN MIXES		
	Refr. Conc.	Std. & Ext. Str.	Super	3000°F	Insul.	Basic	Std.	Super	Cold Set.	Graph-ite.	High Alum.	High Alum.	Basic	Clay	High Alum.	Basic
COKE OVENS																
Doors		X			X				X							
Paving-Top Of Oven	X															
Paving-Bench	X	X														
Jambs															X	
SINTERING MACHINES																
Ignition Arches			X	X					X		X					
Chutes & Dust Collectors		X														
BOILERS																
Walls & Arches		X	X	X	X		X	X	X		X					
Ash Hoppers		X				X										
Baffles		X														
BLAST FURNACES																
Anchoring Wearing Plates	X	X														
Bosh & Inwall Patching		X		X										X	X	
Domes					X											
Gas Cleaning Equip.		X														
Goose Necks		X														
Packing	X	X			X											
Packing Around Cooling Plates		X						X	X	X						
Paving	X															
Piping		X			X											
Runners										X			X			
Subhearth	X	X														
BLAST FURNACE STOVES																
Base	X	X														
Pilaster		X	X													
Wall Walls		X	X	X												
LADLES & MIXERS										X		X		X		X
OPEN HEARTHS																
Back Wall & Roof Maintenance													X			X
Checker Chamber Roof & Fantail Arches									X							
Doors						X							X			
Flues								X	X							
Hearths													X			
Hearth Maint.													X			
Hot Tops			X	X												
Sealing														X		
Subhearth						X										
Runners & Spouts										X			X			
Tap Holes													X			
Uptakes								X	X							
ELECTRIC FURNACES																
Bottoms													X			
Bottom Maint.													X			X
Roofs				X				X	X		X	X				
Wall Maintenance																X
OXYGEN CONVERTERS																
Hearth													X			X
Hoods		X		X												
Walls													X			X
SOAKING PITS																
Burner Blocks			X	X							X	X				
Coping		X						X	X							
Covers			X	X	X			X	X							
Flues	X	X			X											
Hot Air Piping		X			X											
Upper Walls								X	X					X		
Lower Walls																X
REHEATING FURNACES																
Burner Blocks			X	X				X	X		X	X				
Flues	X	X			X											
Hearth													X			
Hot Air Piping		X			X											
Roofs					X			X	X							
Walls					X			X	X							
ANNEALING FURNACES																
Bases		X			X											
Burner Blocks			X	X				X	X		X	X				
Car Tops		X														
Covers		X			X											
Roofs & Walls		X			X											

Table II
Castable Refractories

Types	Density, lb per cu ft	Temperature service limit, F
Refractory concrete	110–115	1800
Standard	110–115	2500
Extra strength	115–120	2400
Super	115–120	2700
High alumina	135–145	3000–3200
Lightweight	25– 30	1700–1800
Lightweight	50– 60	2000–2600
Lightweight	80– 90	2100–2400
Chrome	160–170	2600–3000
Extra strength chrome	160–170	2500–2600

to the fact that the panels can be cast, cured and dried on the ground in advance of maintenance and construction. Then, as needed, the panels can be installed in walls or arches.

There are four stages in a good castable installation: (1) mixing and placing, (2) curing, (3) drying, (4) firing.

Mixing and placing—Castables can be poured into place or shot into place with a suitable type of gun. If poured, they can be mixed by hand or in a cement or mortar mixer. It is important to use clean water and clean equipment.

The amount of water to use is usually specified by the manufacturer. However, local conditions may govern the amount of water required for a cast or poured job. Generally, the use of a concrete vibrator is recommended to eliminate entrained air and completely fill the form. When a vibrator is used, the water content of the castable can usually be reduced. A refractory castable should not be installed in freezing weather without first making provisions to keep the material from freezing. Freezing of castable will result in inferior installation. Low temperature will retard the setting time, and it is desirable to maintain a temperature above 50 F.

Curing—This means keeping the material wet or the surrounding atmosphere moist. The primary purpose is to assure the complete hydraulic set of the binder. Normally, a period of 12 to 24 hr is suggested. This is accomplished by placing damp sacks over the castable or spraying with a fine mist of water as soon as the castable begins to take its initial set.

A properly cured installation will normally be stronger than one which has not been cured. However, there are some quick maintenance jobs which must dispense with the curing procedure, and castables can be used with satisfactory results under these conditions of emergency.

Drying—Following the curing the material may be exposed immediately to heat or can be air dried indefinitely. The longer the castable dries before heating, the more strength it will develop although the increase in strength usually is negligible after only several days.

Firing—Generally speaking, the size of the mass of castable determines how fast it may safely be brought up to temperature without impairment. Further, the means for the escape of free moisture may have a bearing on the safe firing rate.

PLASTIC REFRACTORIES

Plastic refractories are manufactured from selected calcined and bond clays which are carefully blended and mixed with sufficient water to secure the proper plastic consistency for ramming or pounding into place without further preparation. Plastic firebrick are available for applications up to 3100 F. In addition to the standard, super and high alumina grades, there are modifications available having graphite additions or cold setting properties which considerably enhance these plastic materials for certain specific applications. Table III shows the various grades generally available.

Plastic firebrick is easy to install and is well suited for monolithic furnace linings. It is particularly useful for patching or making emergency repairs to existing refractory settings. In applications such as boilers and some large reheating furnaces, plastic firebrick has been adopted for the entire refractory structure, and service in these applications has quite frequently been equal or superior to conventional refractory construction.

Plastic firebrick is ordinarily furnished in slabs having the proper workability so that they can be readily rammed to the desired wall thickness and contour as a homogeneous monolithic body. The moisture content is maintained as low as possible to minimize drying shrinkage. Cold setting properties have been added to some plastic firebrick for use in those installations where additional strength is required during installation and curing of the refractory setting. However, these cold setting properties do not extend throughout the complete temperature operating range of the plastic material but do provide good strength requirements prior to development of ceramic bond at operating temperature.

The plastic materials with graphite addition find their widest application where they come in contact with molten metals. The graphite or carbon mixtures are not readily wetted by most slags and metals, and therefore the attack by these products on the monolith is greatly reduced.

Upon completion of a plastic installation the refractory structure should be heated to a temperature well in excess of that at which a ceramic bond will develop in the monolithic lining. Precautions should be taken during the early heating to make certain that the hot face temperature does not exceed 500 F until the moisture present in the refractory structure has been driven off. The monolith should be held at the high temperature for a sufficiently long time to develop a good ceramic bond. In the case of the cold setting plastics, it is not imperative that this firing be done immediately. However, the setting should not be permitted to stand for an undue length of time without being heated to high temperatures.

In considering plastic firebrick for any installation, it should be remembered that plastics serve best when operating at high temperatures where ceramic bonds will

Table III
Plastic Refractories

Type	Density, lb per cu ft	Pyrometric conc. equivalent	Temperature service limit, F
Standard	135	31–32	2800
Standard (cold setting)	135	31–32	2800
Super	137	33–34	3000
Super (cold setting)	137	33–34	3000
High alumina	135	35	3100
High alumina (cold setting)	135	35	3100
Super (graphite)	135	32–33	3000
High alumina (graphite)	134	34–35	3100

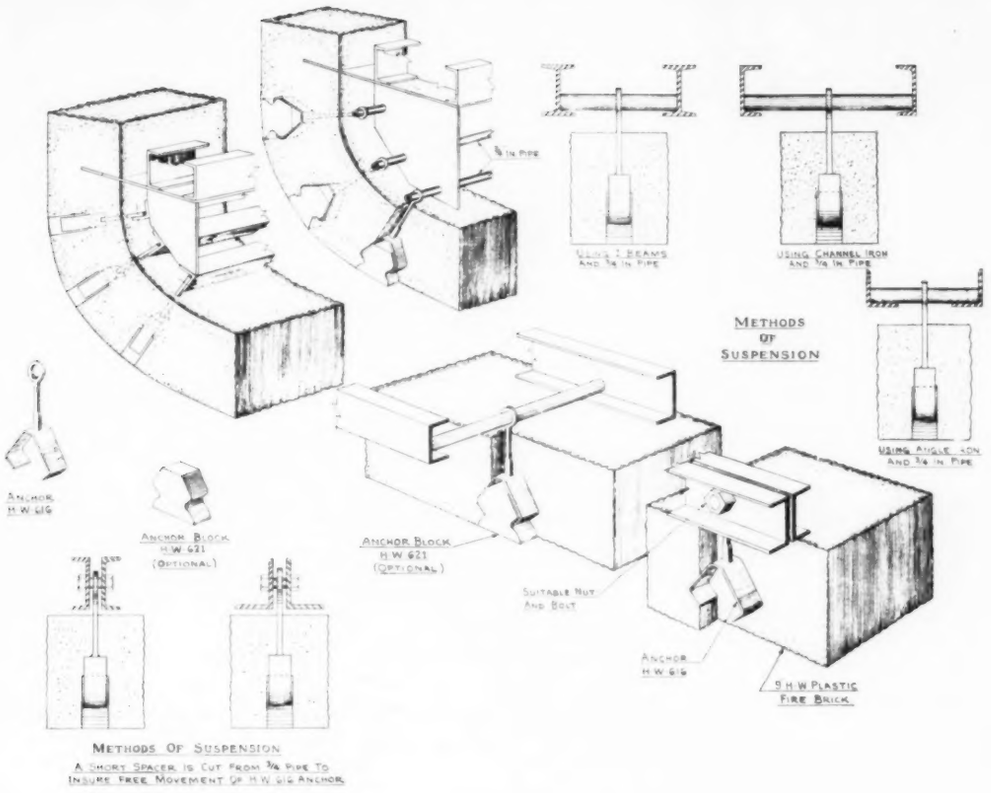

Methods of Suspension
Anchor H-W 616
Anchor Block H-W 621 (Optional)
Anchor Block H-W 621 (Optional)
Suitable Nut And Bolt
Anchor H-W 616
9 H-W Plastic Fire Brick
Methods Of Suspension
A short spacer is cut from 3/4 pipe to insure free movement of H-W 616 anchor

Figure 1 — Anchors provide a means of suspending brick for arch construction.

develop in the hot face of the refractory structure. At lower temperatures, unless the circumstances are unusual, castable materials will in the long run give better service.

Anchoring Devices—Some provision should be made in castable and plastic refractory installations for proper anchoring and reinforcement. In castable installations, a careful analysis of the anchoring system chosen is very important to the ultimate service secured. It is possible to over-anchor with resultant failure due to differential expansion of the metallic anchors and the castable refractory. Various types of anchors are used, these being alloy steel studs, clips or mesh and refractory tile anchors. See Figures 1, 2, 3, 4, 5, 6.

In plastic firebrick installations, provision must be made for a stable anchoring system which may be of several varieties such as heat resisting alloy anchors, a combination of special burned refractory tile and alloy anchors or refractory tile anchors which are fastened to the shell or buckstays with metal clips. The anchors serve merely to keep the plastic in place as it expands or contracts in high temperature service.

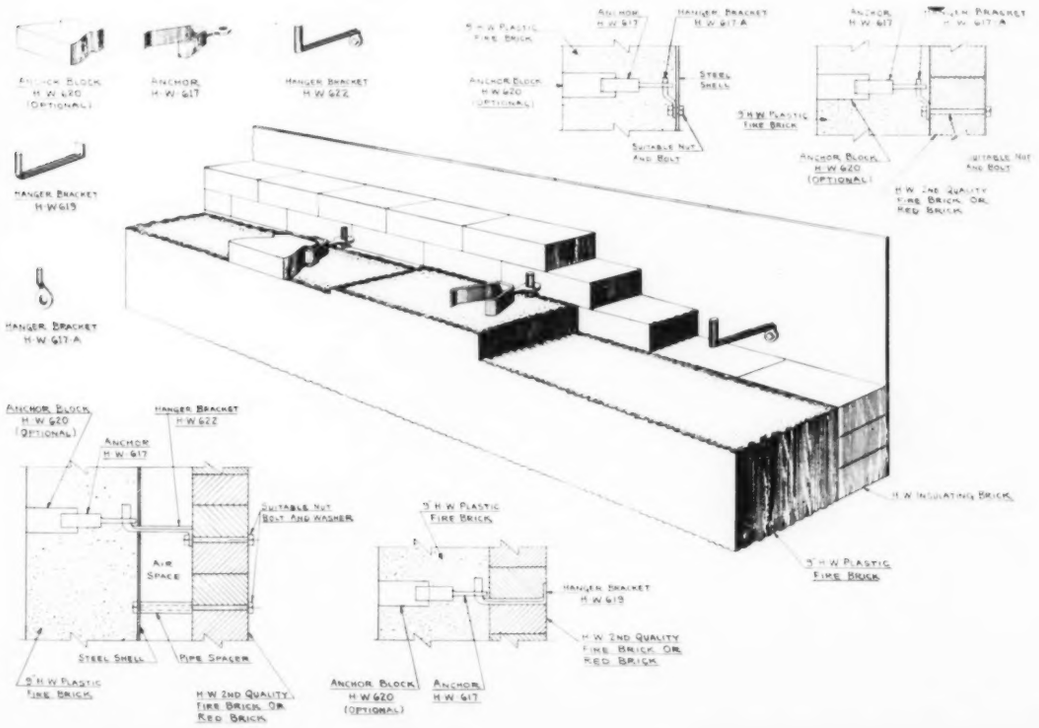

Anchor Block H-W 620 (Optional)
Anchor H-W 617
Hanger Bracket H-W 622
Hanger Bracket H-W 619
Hanger Bracket H-W 617-A
Anchor Block H-W 620 (Optional)
Anchor H-W 617
Hanger Bracket H-W 622
Suitable Nut Bolt And Washer
Air Space
Steel Shell
Pipe Spacer
9 H-W Plastic Fire Brick
H-W 2nd Quality Fire Brick Or Red Brick
Anchor Block H-W 620 (Optional)
Anchor H-W 617
9 H-W Plastic Fire Brick
Hanger Bracket H-W 619
H-W 2nd Quality Fire Brick Or Red Brick
H-W Insulating Brick
9 H-W Plastic Fire Brick

Figure 2 — The bracket assembly method can be used for constructing walls.

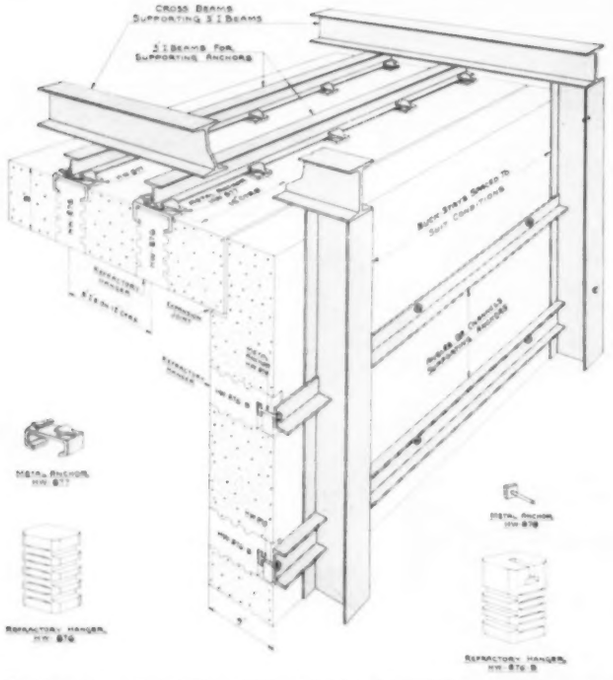


Figure 3 — Typical monolithic refractory furnace construction.

RAMMING MIXES

Ramming mixtures—This particular category of monolithic refractories is manufactured from blended mixtures of refractory aggregates, plasticizing agents and chemical binders. They are shipped either wet or dry. The wet material is of the right consistency for ramming with an air rammer. The dry product is moistened with water to the right consistency for ramming. The various types of ramming mixtures are shown on Table IV.

Ramming mixtures are used in many high temperature applications in the steel plant.

Table IV
Ramming Mixtures

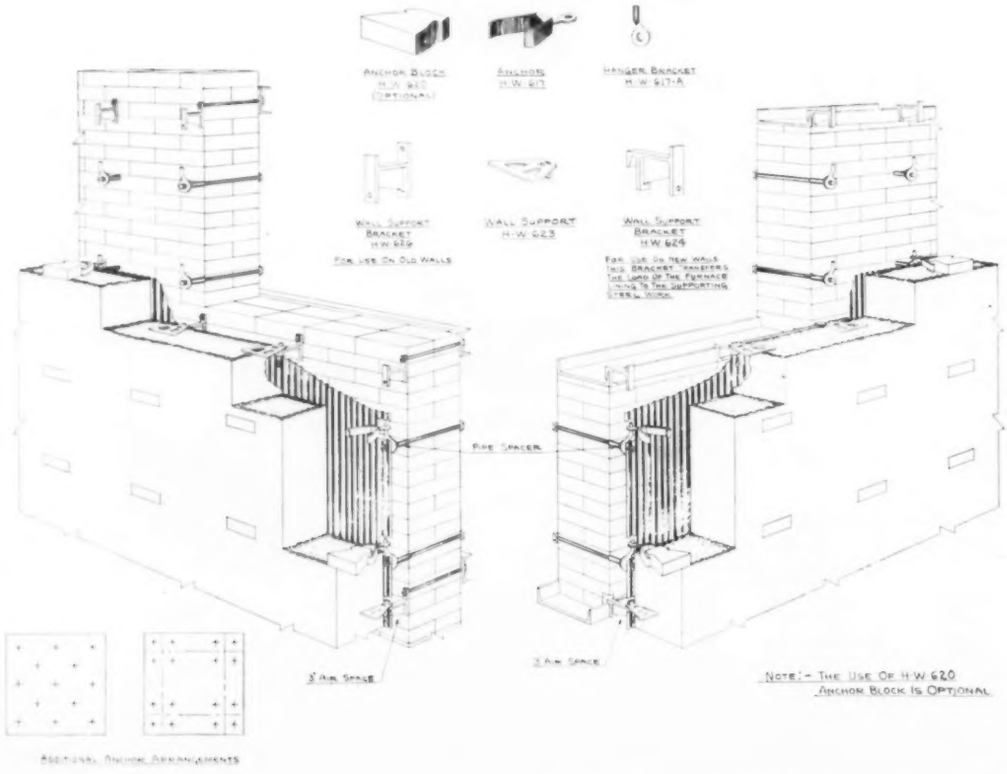
Type	Density, lb per cu ft	Temperature service limit, F
High alumina base, per cent		
70 Al_2O_3	155	3200
80 Al_2O_3	155	3300
90 Al_2O_3	175	3400
99 Al_2O_3	185	3600
Chrome base	190	3100
Magnesite or periklase base	170	3200

In using ramming mixes, solid forms should be provided to hold the material firmly in place until installation is completed. To provide for maximum density and true monolithic construction, the blows of the rammer should be directed in such a manner that lamination planes are not parallel to the hot face of the rammed material. After installation of each batch of material, the smooth surface formed by the rammer should be roughened with a trowel or small rake to eliminate laminations and provide a continuous bond from batch to batch. If it is necessary to interrupt the ramming operation for more than one hour, cover the uncompleted mass with a damp cloth or sack so that this face will remain moist and the new material will bond to it properly.

Refractory gun clays—These products must be applied with one of the various types of air placement guns. If the gun is of the type that the water is added at the nozzle, it is recommended that the clays be predampened with about 2 to 3 per cent moisture to eliminate extreme dustiness in shooting the material on the wall. It is desirable to use a cold setting gun clay on cold furnace walls and a heat setting gun clay on hot walls.

Applications—present and future—Monolithic refractories are currently being adopted for certain applications within the blast furnace itself. Perhaps the most

Figure 4 — This air-cooled, sectionally-supported wall uses anchors, supports and brackets.



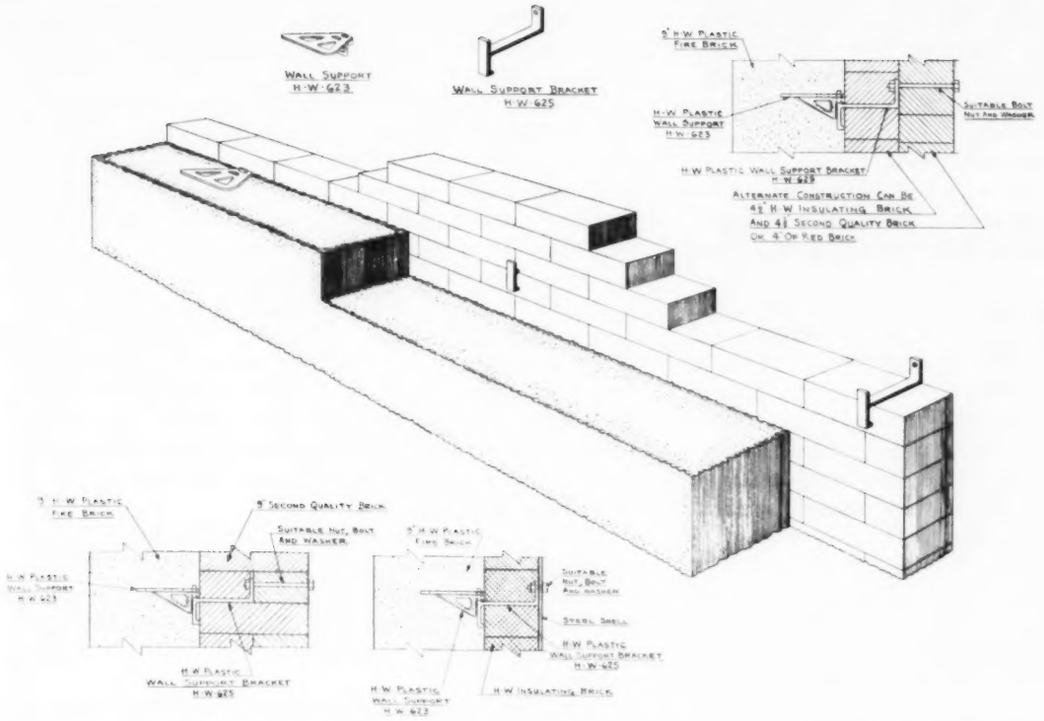

WALL SUPPORT H-W-623
WALL SUPPORT BRACKET H-W-625
9" H-W PLASTIC FIRE BRICK
H-W PLASTIC WALL SUPPORT H-W-623
SUITABLE BOLT NUT AND WASHER
H-W PLASTIC WALL SUPPORT BRACKET H-W-625
ALTERNATE CONSTRUCTION CAN BE 4½" H-W INSULATING BRICK AND 4½" SECOND QUALITY BRICK OR 4" OF RED BRICK
9" SECOND QUALITY BRICK
STEEL SHELL
H-W INSULATING BRICK

Figure 5 — There are various methods of securing the supports of sectionally supported walls.

interesting of these is the use of plastic firebrick and, graphited plastic firebrick for packing around bosh and inwall coolers. The graphited plastic in this application are preferred because of their higher thermal conductivity.

In this application the monolithic materials eliminate the special shapes and tedious bricklaying over the coolers. Generally two courses of open brickwork are sufficient to accommodate most of the cooler designs. At the heel the cooler is approximately 4½ in. thick, and this allows an open space of about ½ to ¾ in. on both top and bottom. The cooler then tapers to approximately 2½ in. at the toe with the additional space being filled with the monlithic material. In addition to simpliflying the masonry work, the cooler design can be simplified in that the top of the cooler can now be made flat instead of arched.

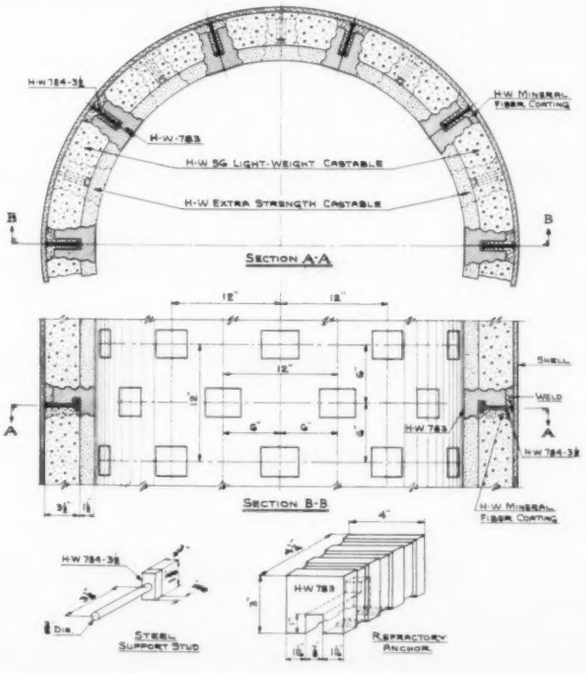
For packing behind the lining proper, refractory concretes and insulating castables are being used advantageously. The hydraulic setting properties of these materials assure the operator that there will be no settling or additional packing of this fill material that could result in voids particularly in the upper portion of the lining. There are also low iron castables (less than 1 per cent Fe_2O_3) available for this application as may be required.

In addition to using castable for packing, they are quite generally accepted for use in the anchoring of wear plates. For this application, the high strength castables are generally preferred.

During the recent recession some few blast furnaces were blown out, and on inspection it was determined that the lining would be quite satisfactory for additional tonnages. Both castables and clay materials have been gunned on worn linings to return these furnaces to near their original contours. The true worth of the monolith in this application cannot be easily evaluated. However, in each case, the furnace has operated more satisfactorily after blowing in than it did prior to being taken out of service. This indicates that the monolithic materials provided the needed refractory for proper furnace operation and should materially increase the tonnage produced on these linings.

Soaking pits, because of the many variables in operation, occasionally have relatively high refractory maintenance costs. In many shops monolithic construction of walls, burner ports, coping, and covers has very materially decreased these costs. For example, basic castables and ramming mixes are used in the lower walls, fireclay and high alumina castables are used for maintaining upper walls, and plastic firebrick is used for coping and upper walls. The covers are completely cast or gunned with castables or are rammed with plastic firebrick. A recent development is the use of light weight

Figure 6 — Typical arrangement of anchors used with monolithic refractory.



2800 F insulating castable for the covers. Thus, where weight is a factor, the light weight cover is very advantageous. Certain designs of covers require the mitering of brick work, whereas, with monlithic construction this is unnecessary.

The question often arises concerning the selection of castable and plastic firebrick in monolithic construction. As is shown on accompanying table, both of these groups of products are being used in similar applications. The selection to date has largely been one of construction convenience and operating conditions. Some operators argue that castable refractories in some instances provide too rigid construction for maximum service and therefore prefer plastic firebrick construction. Other operators point out that castable is easier to install either by casting into forms or applying with air placement guns. They claim, the service secured from this type of construction is comparable to plastic firebrick and the installed cost is less. Therefore trials of each of these monlithic refractories should be arranged and performance and costs carefully analyzed on a number of furnace installations before a decision is made. This method of analysis is also being followed in the selection of various types of castables and plastic firebrick currently on the market.

The art of monolithic construction has been further promoted by careful attention to installation procedure and stable anchoring arrangements. That the best performance can be secured from monolithic refractories when careful attention is paid to proper mixing, placing, curing, drying and firing of these products cannot be overemphasized.

Discussion

PRESENTED BY

GEORGE ANTHONY, Ceramic Engineer, Campbell Works, Youngstown Sheet and Tube Co., Youngstown, Ohio

CHARLES R. HAUTH, Technical Sales, Harbison-Walker Refractories Co., Pittsburgh, Pa.

George Anthony: There is no question that plastics, castables, ramming mixes and gunning mixes are finding increased usage each year in the steel plant. A study of the United States Department of Commerce reports on refractory shipments shows this trend, and it is expected that these materials will find continued increased use.

Among the many things stressed by the authors to insure a good castable or plastic installation, I would like to stress particularly the use of a well designed refractory hanger; and, in those cases where necessary, an alloy support of sufficient temperature resistance to withstand the severity of the service.

One of the other things I would like to mention is that when a plastic refractory is used, a material of low drying shrinkage should be chosen. Attention to such details can mean the difference between a good installation and a poor one or possibly a complete failure. In some applications such as soaking pit covers, vibration is often encountered along with some pretty severe abuse which would make the use of an air setting plastic appear desirable.

In closing, I would like to ask the authors this question. What use is being made of low iron castables, both heavy and light weight, in the construction of heat-treating furnaces, in particular those which contain controlled atmospheres of highly reducing compositions?

Charles R. Hauth: In regard to the low iron castables, they are now available in both heavy-duty and in light weight grades with the iron oxide content less than one per cent. An iron oxide content of less that one per cent does not guarantee a product which is completely immune to the effects of carbon monoxide. In laboratory tests using a 99 per cent carbon monoxide atmosphere, we have definitely proved that low iron castables are more resistant to carbon deposition than those of usual higher iron content.

The carbon monoxide content of controlled atmosphere furnaces rarely exceeds 20 per cent, and while we cannot guarantee that with this concentration the low-iron castables will be completely immune, we certainly believe that a trial of these low-iron light weight castables is warranted.

We do know that in some furnaces where the carbon monoxide concentration is much lower, for example, five per cent, that conventional castables with higher iron oxide content serve satisfactorily. Use of low iron castables for these applications will provide a safety factor. ▲

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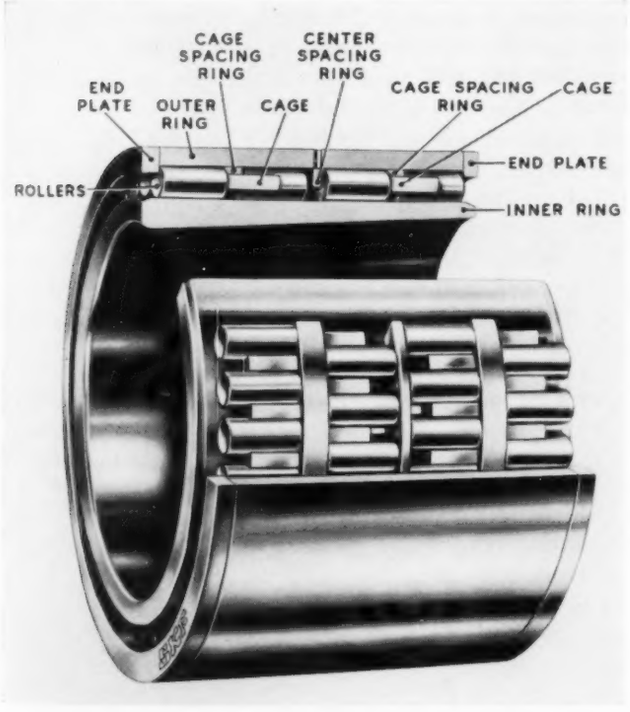
Recent Developments in Roll Neck Bearing Design and Mounting

by E. C. Denne, Jr., Manager, Rolling Mill Dept.,
SKF Industries, Inc., Philadelphia, Pa.

A straight bore, loose neck bearing design has been developed for mills not requiring the advantages of a tight fit bearing.... one-piece, tapered inner ring makes mounting easier and interchangeability possible.

Figure 1 — A 4-row cylindrical roll neck bearing with a one-piece, tapered inner ring makes mounting easier and makes manufacturing for complete interchangeability possible.



THE multi-row cylindrical roll neck mounting consists of two separate parts, a 4- row cylindrical radial bearing for the heavy mill separating loads and a separate thrust bearing for the axial load. Along with closely related subjects this paper describes some of the many possible multi-row and thrust bearing combinations which satisfy the most exacting mill requirements.

THE BASIC MULTI-ROW DESIGN

The multi-row cylindrical roll neck bearing, Figure 1, consists of four rows of modified cylindrical, through-hardened steel rollers with their length-to-diameter ratio held to an efficient 2 to 1. Two bronze cages with staggered pockets separate the rollers, and hardened steel spacing rings and end plates effectively guide them. Centerless ground, through-hardened steel outer and inner rings form the cylindrical roller paths. All parts are completely separable.

The inner ring or heart of the multi-row has either a straight or tapered bore. The tapered bore design gives a desirable tight neck fit which can be easily obtained with a hydraulic ram. Because the inner ring is but one piece, oil may be injected at its fit surface to assist in "floating" it into mounted position on the roll neck. This important feature not only greatly reduces the required drive-up forces but precludes scoring the roll neck. This feature is very advantageous when mounting a large bearing. For dismounting, the one-piece construction requires but one hydraulic connection to release the complete bearing and chock assembly.

Refusing to compromise on the importance of a one-piece inner ring, we have obtained what is believed to be the largest bore grinders of their type for manufacturing this unit construction. The machine is designed primarily for centerless bore grinding but can also be used for outside diameter and end grinding. The design of the machine was based on experiences gained over the past several years on an expanded centerless grinder doing the same type of work. Its capacity for grinding

Figure 2 — A universal sine bar gage has been developed for accurately measuring tapered necks.

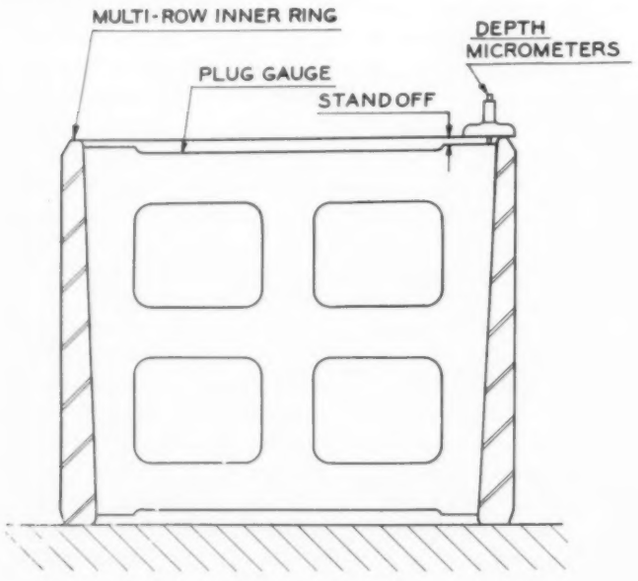
cylindrical and tapered bores and outside diameters are as follows:

	Boring		
	Bore, in.	Width, in.	Outside diameter, in.
Minimum	24	25	27
Maximum	57.5	43.3	60
	Outside diameter grinding		
	Width, in.	Diameter, in.	
Minimum	36	46½	
Maximum	50	61½	

The maximum workpiece weight is 4850 lb.

To obtain correct roll neck taper, a universal sine bar gage, Figure 2, has been developed to replace ring gages. Basically the sine bar resolves the taper into diameters that are easily measured. The carriage accurately alines the sine bar so that the bar is correctly located with respect to the roll axis. A rubber strap is used to hold the assembly in position on the tapered neck. A number of different length sine bars can be applied for different width tapered necks with the same carriage thus giving this design its universal characteristic.

Figure 3 — Making a stand-off measurement with a plug gage and grinding the large-bore end of the inner rings accordingly result in almost identical large-end inner ring bores for like bearings.



Without removing the roll from the roll grinder the sine bar is positioned on the roll neck with respect to some reference point, and diameter readings are made across the sine bar. Thus the accuracy of the taper is quantitatively determined. Such a measurement is impossible with a ring type gage which can give only a qualitative measurement. The required taper angle accuracy is obtained by holding the measurements for the small and large ends of the taper within 0.001 in. The least critical deviation is an undersized large end. If these two measurements do not agree within tolerance at the start of grinding, the exact amount which the grinder must be adjusted to give the desired geometry is readily apparent. Once the grinder has been set to give the proper taper, stock is removed from the neck until the absolute diameter at the small end of the taper is within the drawing's tolerance. This insures that the relative axial position of the taper is correct. Three years field use of this gage has resulted in its acceptance by roll manufacturers.

The tapered bore multi-row is designed for driving the bearing inner ring against the inboard fillet ring next to the roll barrel. Thus, instead of the maintenance man having to measure the axial drive-up to obtain the correct tight neck fit, he simply drives the bearing until a sharp rise in pressure is noted on the hydraulic pump gage. To make this system workable all inner rings of the multi-row bearing have been manufactured for full interchangeability, bearing to bearing and roll neck to roll neck. Figure 3 illustrates the gaging method used to gain interchangeability. A plug gage is placed in the bore of the inner ring, and a stand-off measurement is taken after the bore and outside diameter of the ring have been ground. This measurement is made the same for every bearing by surface grinding the large-bore end face. Since a variation of 0.003 in. on the stand-off dimension reflects in a variation of only 0.00025 in. in the bore diameter, it is quite easy to produce bearings with virtually identical large-end bores.

To achieve correct "timing" of the roll neck taper with respect to the inboard fillet ring an inner ring is seated on the roll neck (not driven up), and a gage block is placed on the inner ring to measure the stand-off between the inboard face of the multi-row inner and the face of the roll barrel. Figure 4 illustrates this setup. The gage block is made for a particular bearing size and automatically incorporates the amount of drive-up. Thus, the measurement taken gives the correct width to which the fillet ring should be machined to insure correct drive-up of the bearing. Once a fillet ring has been machined to its proper width, it is shrunk on its particular roll neck and remains with that roll neck. This gives complete assurance that any bearing inner ring can be put on this roll neck and driven up the correct amount without taking measurements.

For mills not requiring the accuracy insured by a tight neck fit, a loose fit, straight bore multi-row design has been developed. Moreover, the conventional loose neck design has been improved upon without destroying

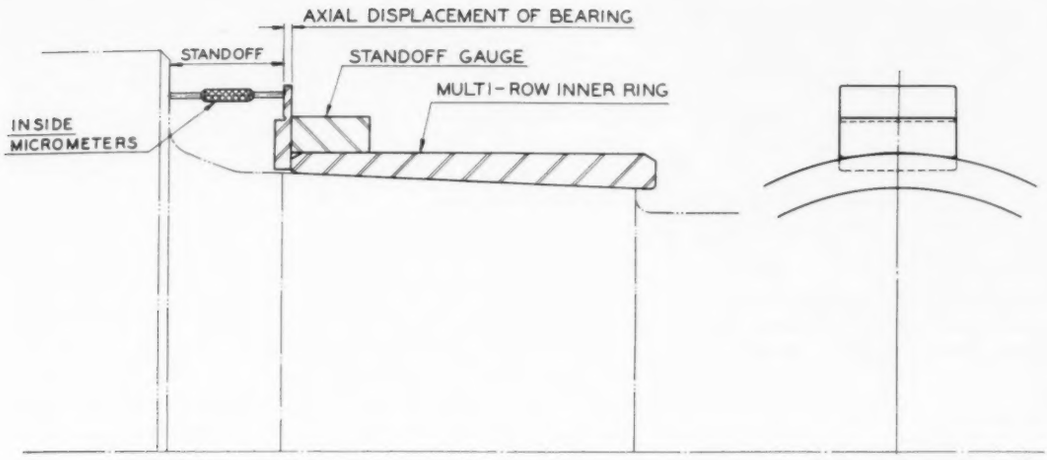


Figure 4 — The use of a gage block as shown here makes possible an easy, direct measurement of the standoff to which the fillet ring width will be ground.

the quick roll changing advantage of this mounting. In England a spiral groove was ground into the bore of a roll neck bearing to stop cracks resulting from heat checking due to creep induced by loose neck fits. Semi-circular grooves, 0.087 in. deep, were ground on a 0.79-in. pitch in the bore of a 25½-in. bore, 40½-in. outside diameter backup roll bearing. After 5000 to 7000 hr service in stands 3, 4 and 5 of a 21 and 46 x 56 -in. 5-stand tandem, 1500-fpm cold mill; the bores were in exceptionally good condition, Figures 5 and 6. No smearing cracks developed, and it appeared that the spiral grooves assisted not only neck lubrication but the collection of foreign matter. The roll necks accordingly benefited from this practice.

Although the size and pitch of the bore grooves are not too critical, it has been found that different groove depths and pitches give somewhat varied results. The very fact that the groove is a spiral rather than a number of circular grooves seems to assure the success of this design.

For either the straight or tapered bore mounting separate thrust bearings must be used. This makes possible greater flexibility permitting design of more effective mills. Angular contact ball bearings are used in mills requiring close axial stabilization of the rolls. Where such accurate alignment is not required, heavy duty, double directional thrust bearings are used. In either case mills may be designed with precision axial adjustment systems permitting movement of the roll between the multi-row inner ring and the roller complement.

BEARING RATINGS

Before discussing specific mountings using these design features load ratings of large anti-friction roll neck bearings will be reviewed. Some bearing users have repeatedly protested against the difficulty or impossibility of comparing the load carrying capacity of bearings made by different manufacturers while other users have accepted bearing manufacturers ratings without question. For the former group, the Anti-Friction Bearing Manufacturers Association (AFBMA) published a standard in December, 1957, on the "Method of Evaluating Load Ratings of Roller Bearings," It is followed by several bearing companies in recent catalogues. This method is based mostly on experiment and theory representing the composite work of the various companies belonging to the AFBMA. It may be used with the full assurance that it represents the best thinking of many anti-friction bearing manufacturers.

The group of users who rely wholly on the published ratings of bearing manufacturers should be cautious. Large roll neck bearings have never been subjected to fatigue tests similar to those smaller bearings have been

Figure 5 — In England a spiral groove was ground into the straight-bore inner ring to stop cracks that result from heat checking.

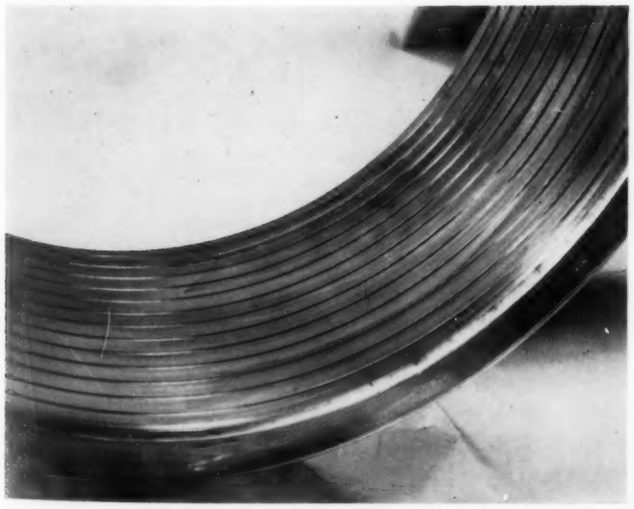


Figure 6 — A closeup of the ring of Figure 5 after 5000 to 7000-hr service in a 21 & 46 x 56-in., 5-stand, 1500-fpm cold mill.

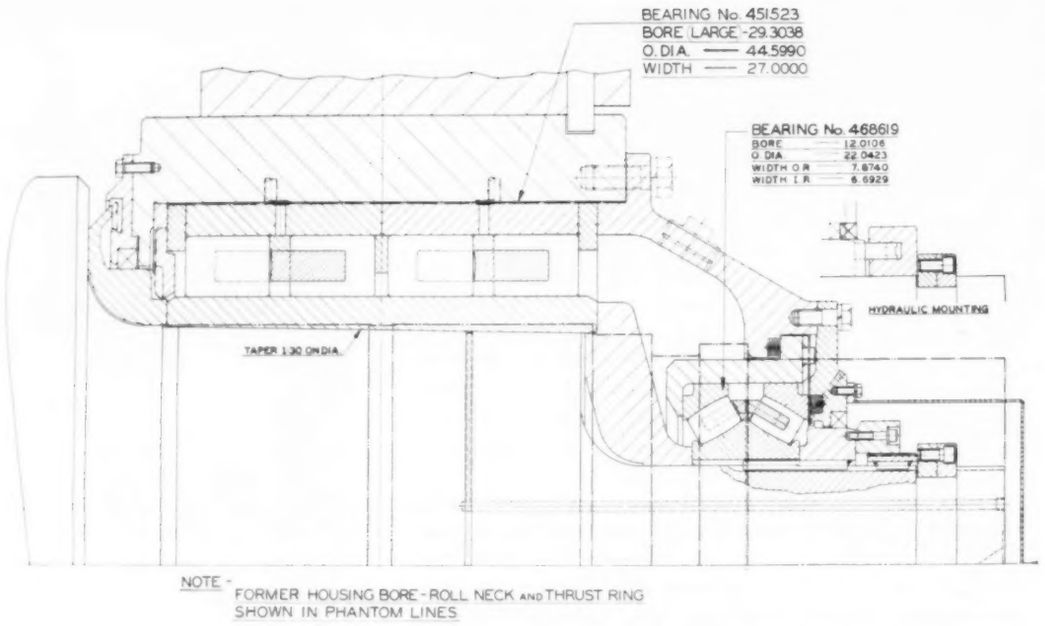

BEARING No. 451523
BORE LARGE -29.3038
O. DIA. —— 44.5990
WIDTH —— 27.0000
BEARING No. 468619
BORE 12.0106
O. DIA 22.0423
WIDTH O.R 7.8740
WIDTH I.R 6.6929
HYDRAULIC MOUNTING
TAPER 1:30 ON DIA.
NOTE - FORMER HOUSING BORE - ROLL NECK AND THRUST RING SHOWN IN PHANTOM LINES

Figure 7 — This tight neck bearing on the thrust side of a 4-high temper pass mill eliminated the roll neck wear and strip chatter formerly present with a loose neck bearing.

subjected to over a period of many years, nor has the actual application in rolling mills given any exact rating results since loads, speeds and times of operation vary so greatly. The result is that large bearings are rated according to methods proved on smaller bearings. These ratings are tempered with actual rolling experience. It is understandable that some differences of opinion should exist among bearing manufacturers concerning the rating of large bearings since there is no controlled experimental proof that these published ratings are absolute. At the same time ratings as determined by any one manufacturer are generally relative.

With these thoughts in mind, when the large bearing ratings of one manufacturer are compared with another's ratings, the same method should be used whether it be the AFBMA or any other suitable method. The AFBMA has cleared up much confusion surrounding bearing ratings. It is hoped that eventually all anti-friction bearing manufacturers will subscribe to this standard method for rating bearings. Users have demanded standard rating methods from other industries, such as the AGMA for gearing. Why not demand a standard rating method from the bearing industry? This could be accomplished by asking bearing suppliers to submit AFBMA ratings.

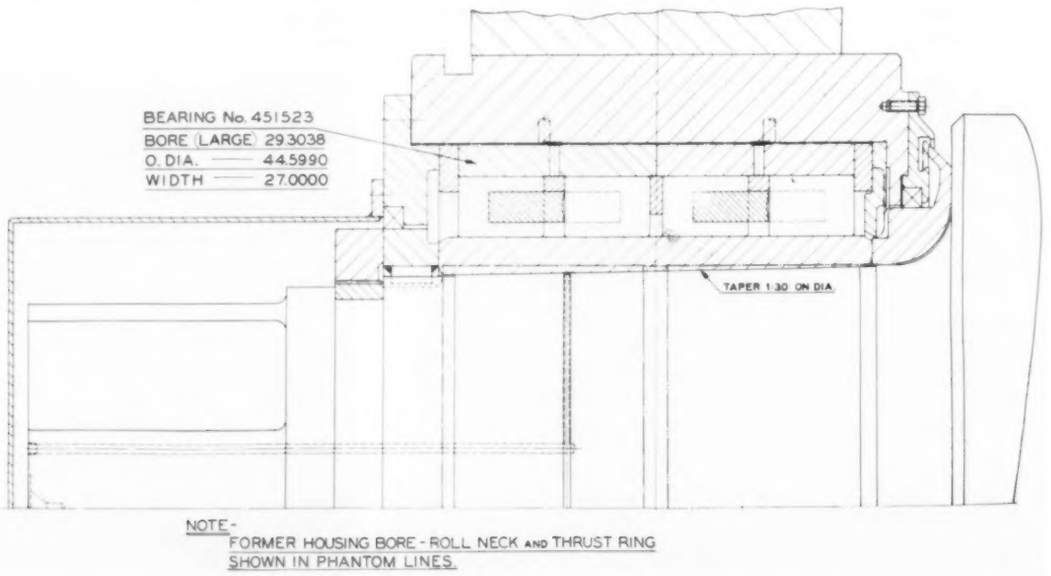
MULTI-ROW CHANGEOVER DESIGN

The easy adaptability of the multi-row mounting to changeover designs is readily apparent. Its small section height and high capacity are advantages for changeovers. Generally modification to existing rolls and chocks is all that is required.

As a case in point, a large steel mill was having trouble on a 4-high temper pass mill with strip chatter, severe roll neck wear (up to 0.210 in. on diameter), and sealing problems. This 20 and 48 x 84-in. mill, although rated at 2000 fpm., could not roll at much over half rated speed for many rolling schedules because of excessive mill vibration. The loose neck fit, 4-row tapered roller bearing formerly used on the mill had a 29½-in. bore, 44½-in. outside diameter and 27-in. width.

Figure 7 shows how the change to the multi-row was accomplished on the thrust (or operating) side of the mill using the same rolls and chocks. The phantom lines depict the previous roll contour which was reworked to

Figure 8 — Floating side of the temper mill of Figure 7.


BEARING No. 451523
BORE (LARGE) 29.3038
O. DIA. —— 44.5990
WIDTH —— 27.0000
TAPER 1:30 ON DIA.
NOTE - FORMER HOUSING BORE - ROLL NECK AND THRUST RING SHOWN IN PHANTOM LINES.

accommodate the new mounting. The chocks were rebored to true them up. Figure 8 shows the floating or drive side of the mill which required very little change of existing parts to accommodate the multi-row cylindrical bearing.

With this new tight neck fit mounting inner ring creep resulting in severe scoring and wear between the inner ring bore and the roll neck has been eliminated; the mill has consistently run at speeds up to its maximum capacity of 2000 fpm on all rolling schedules thus increasing production. Without roll neck wear the seals are held concentric and thus are more effective. Roll expansion now takes place between the inner ring outside diameter and the roller complement rather than between the screw load and the chock thus relieving the radial bearing from this parasitic thrust load. Rolls are ground on fully interchangeable, centerless ground bearing inner rings applied to the roll necks which are supported in the steady rests during roll grinding to give close concentricity between bearing and roll barrel.

It had been hoped that the change to the tight neck fit cylindrical bearing that permits unrestricted heat expansion of the mill rolls would also eliminate the chatter problem. It apparently has been of some help since there has been only spotty reoccurrence since the change.

Strip chatter (known by such names as washboard, shadow, pattern, etc.) is a complex problem which has cost most mills considerable time and money. It seems to be as widespread as the common cold and generally has as many treatments for its cure. In trying to obtain written material on the subject, it was of interest to find that no one seems to have formalized their views on the problem. Perhaps the reason lies in the fact that so many changes are made at one time in an effort to relieve the situation, the true cause or combination of causes is not generally as clear cut as would be desired. Many have their own special ideas on the subject, most of which revert to the roll grinder.

IMPROVED MULTI-ROW ROD MILL DESIGN

Besides the multi-row's versatility in changeovers, improved mountings that better suit particular rolling requirements are made possible. Figure 9 shows a special multi-row design engineered for high-speed rod mill roll necks. The inner ring of the multi-row has been extended to form a seat for the angular contact thrust bearings. When the multi-row is driven up the tapered neck, the inner ring expands providing a tight fit between it and the bore of the angular contact bearings. this precludes creep with resulting bearing bores, bearing end face and roll neck wear. Also, the expansion of the inner ring preloads the thrust bearings in their mountings so that axial roll movement is restricted. No matter what the internal radial looseness of the multi-row, this design insures concentric running between the multi-row and the rather sensitive angular contact bearings, which is a necessity for good angular contact bearing performance in high-speed operations.

One of the major mill builders became interested in this extended inner ring, multi-row design and developed a technically sound, precision axial adjustment system around it, Figure 10. This device not only permits very fine axial adjustment of the roll within the bearings but is unaffected by vertical roll adjustment or roll deflection as is, or can be the case, with presently used adjusting devices.

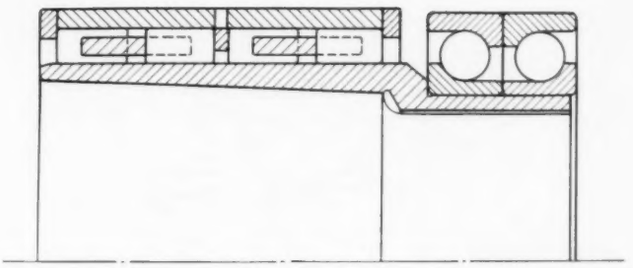
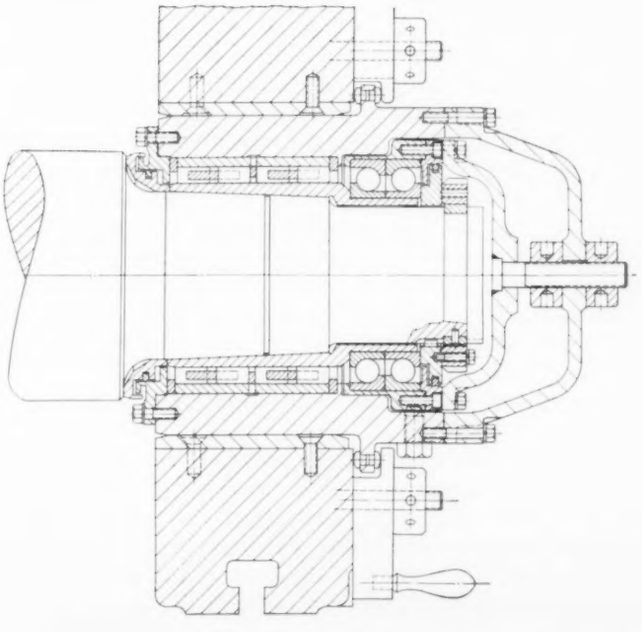


Figure 9 — The inner ring of this multi-row, cylindrical roll, rod mill neck bearing was extended to form a seat for the angular contact thrust bearings.

The axial movement of the roll inside the bearing is necessary for the proper operation of this system. The drive side multi-row has no companion thrust bearing. This means the drive side chock must be held with respect to the operating side chock. This is achieved in the bottom chocks by the roll changing sled acting as a spreader bar between the chock rockers. The mill screws are designed to hold the top chocks with respect to each other. The operating side chocks, containing the angular contact thrust bearings, are held with respect to the mill post by wings located on the chock. Buttons on the wings permit chock alinement when clamped to the mill post by keeper blocks. In other words, the chocks on the same roll are held with respect to each other and the held chock fixed with respect to the mill post.

The adjusting device consists of a bell-shaped end cover attached to a sleeve over the outer rings of the angular contact thrust bearings. A second bell-shaped end cover is fixed to the chock. Relative axial movement between these two parts is achieved with adjusting nuts which are readily accessible and easily adjusted with a bar. Adjustment of the nuts moves the roll axially the required amount to properly line up the roll

Figure 10 — This extended inner ring, multi-row bearing permits very fine axial adjustment of the roll within the bearings but is unaffected by vertical roll adjustment or deflection.



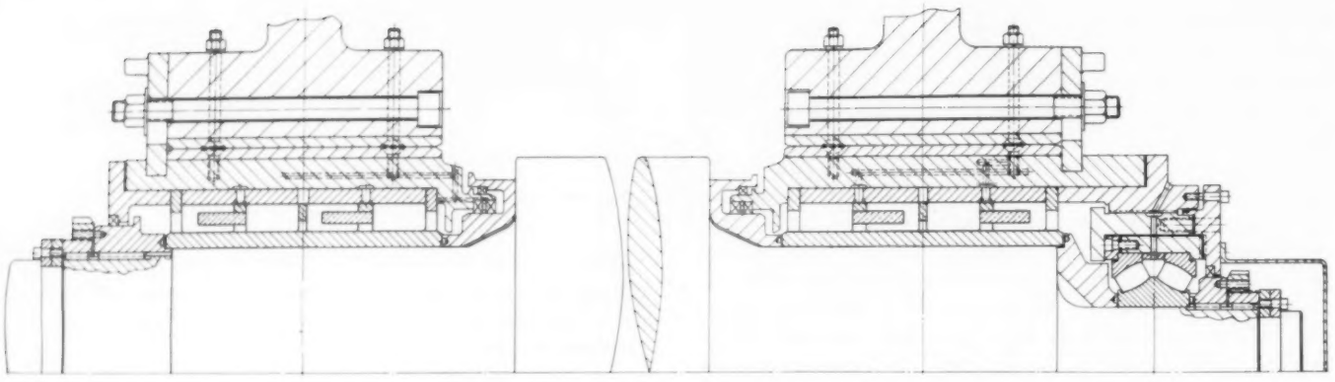


Figure 11 — This is a straight bore, multi-row roll neck bearing for a new blooming mill under construction. Its inner ring has spiral grooves in its bore, and axial roll adjustments are made by turning the outside threaded sleeve over the thrust bearing.

passes. Note that the chocks themselves do not move.

A 23-stand wire rod mill, which went into operation the early part of 1958, has two 12-in. intermediate and six 10-in. finishing stands equipped with essentially this design. Although the bearings on this 6000-fpm mill have not had enough service to draw any definite conclusions concerning bearing life, nine months of rolling has revealed its ease of operation and the accuracy of this axial adjustment method. Already it indicates that the design's reliability will live up to expectations.

This same basic design has been proposed for slower speed stands using a loose neck fit, straight bore, multi-row mounting. Accurate axial adjustment of the rolls in the roughing and intermediate stands can be accomplished quite easily by moving the roll inside the multi-row cylindrical bearings (between the outside diameter of the inner ring and the cylindrical rollers) rather than trying to move the chocks and rolls as is the case with combination radial-thrust bearing designs.

STRAIGHT BORE MULTI-ROWS ON NEW BLOOMING MILL

Figure 11 shows a new blooming mill design which is under construction at the present time. This 40 x 90-in. mill utilizes a straight bore, loose neck fit mounting with extra axial float incorporated on the outside diameter of the multi-row inner ring to take care of axial roll adjustment similar to the smaller rod mill designs. Accurate adjustment is accomplished with minimum effort by turning the threaded outside diameter sleeve over the heavy duty, steep angled, spherical roller thrust bearing. A vernier locking bolt holds the adjustment at the precise setting. The multi-row inner ring has spiral bore grooves, as previously described, to minimize roll neck and bearing bore wear due to creep (see Figure 5). Since the inner ring of the multi-row does not carry thrust loads, wear on the end faces of the bearing inner ring and inner ring spacer will be minimized. Grease lubrication will be used for both radial and thrust bearings.

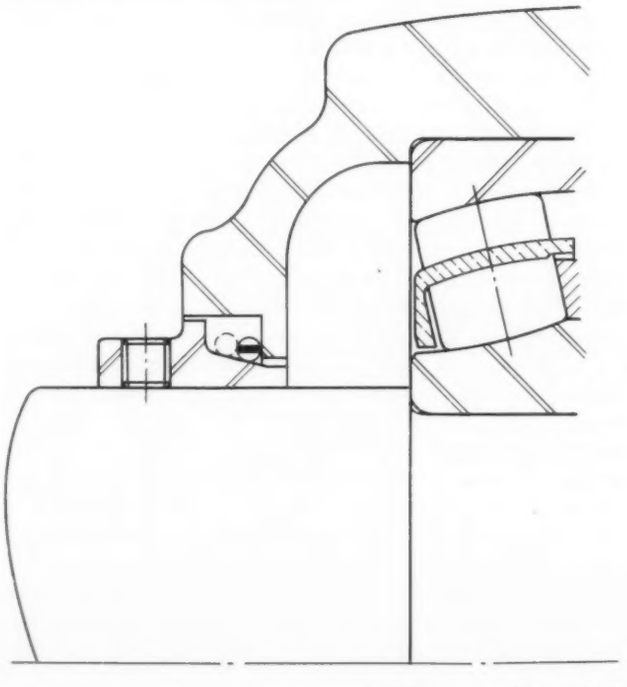
Reviewing recent activity concerning anti-friction roll neck bearing designs and mountings would not be complete without previewing ideas that are being investigated at the present moment. The first concerns a sealing arrangement that shows promise, and the second concerns a new work roll bearing design.

O-RING SEALS

Since seals are so closely related to bearing mountings, a review of some tests made on a new method of utilizing O-rings as sealing elements is of interest. The basic principle consists of stretching an O-ring on a tapered seat thus giving to the O-ring a tendency to move in an axial direction. If this axial movement is restricted, by a bearing housing, the O-ring will exert a pressure against the housing, Figure 12. As the tapered seat turns, the O-ring turns with it forming a tight seal between the O-ring and the tapered seat. The actual sliding occurs between the O-ring and the housing wall. For this design it has been found that O-rings should be made of oil resistant material that does not age (aircraft quality). O-rings of inferior quality often have rough surfaces, and after some operation their elasticity will be reduced.

For the tests made thus far the included angle of the taper has been between 20 and 40 degrees, the expansion of the O-ring 10 to 15 per cent, and the maximum di-

Figure 12 — A rubber O-ring stretched on a tapered seat provides a good seal between its seat and the member that prevents it from moving axially.



ameter approximately 6 in. Results of these tests have been quite promising. A 200-ft head of water and generous quantities of mud and fine grained sand have been completely sealed from bearing chambers up to 1000 hr at peripheral speeds up to 1100 fpm without visible wear to parts.

The simplicity of the design lends itself to numerous variations. For instance, if axial movement of the shaft is required, a design could be like the one shown in Figure 13. The seal stays with the shaft when the housing is removed. This would seem to lend itself to rod mill roll neck seal designs. A simple variation to get greater sealing pressure would be to add another O-ring in back of the first one as shown.

For larger mills it would not be too difficult to visualize a seal that would permit large axial movement as well as misalinement as shown in Figure 14. The O-ring seals "A" ride on the tapered outside diameter of ring "B" which permits axial movement by sliding on part "C". A static O-ring seal between parts "B" and "C" prevents leakage at this point. Rolling coolant or bearing lubricant could seep into chamber "D" but could not get out. A fluid trap would be built up in this chamber which would make the seal even more effective.

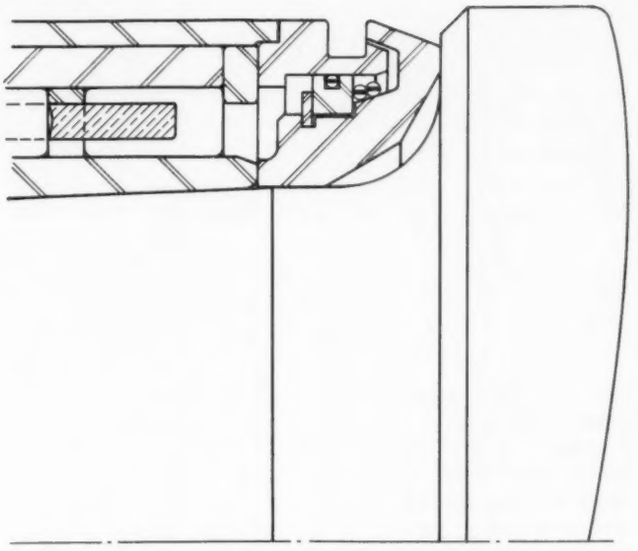


Figure 13 — This double O-ring design, which gives better sealing, permits axial adjustment because it stays with the shaft when the housing is removed.

NEW WORK ROLL BEARING DESIGN

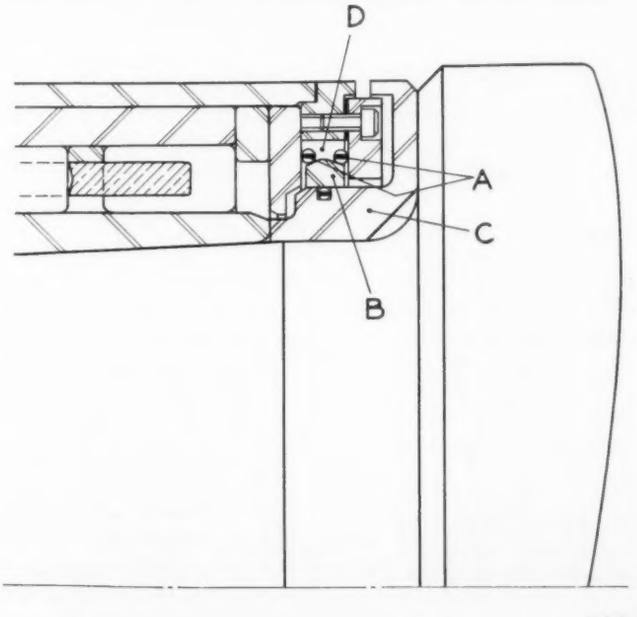
The 4-row, tapered roller, straight bore, loose neck fit bearing design in Figure 15 is the standard work roll bearing type in this country. For practical reasons any attempt to improve the performance of this standard design is necessarily limited to improvements within the present boundary dimensions (bore, outside diameter, width) preferably without any changes to the mill parts. Longer life has been achieved by changes in internal geometry as well as improvement in the quality of the bearing steel. These approaches have their limitations. This application has now been studied with an eye to changing the bearing type within the standard boundary dimensions in an effort to further improve the over-all life.

To appreciate the reasons for the particular type design which has resulted from this study, an understanding of the load distribution within a standard 4-row tapered roller bearing is needed. Even though it is statically indeterminant, this problem may be approached by considering the load distribution within single and double-row, tapered roller bearings and then applying this to the 4-row design.

In the single-row tapered roller bearing a lesser or greater part of the circumference is loaded according to the resultant direction of the radial and thrust load on the bearing. Assume that a radial load only is applied to the bearing. For this condition the bearing rings would separate and thus be inoperable. This is similar to a block sliding down an inclined plane with no horizontal push to keep it from sliding. A thrust load equal to approximately 1.25 times the radial load times the tangent of the contact angle (½ the cup included angle for this design), i.e., $F_a = 1.25\ F_r \tan \alpha$, is required to make the bearing operate satisfactorily. For the normal range of contact angles, between 10 and 30 degrees, this minimum thrust load must be equal to approximately ¼ to ¾ of the radial load. If the radial load remains constant and increasing thrust loads are applied, the bearing rings and rollers come into more intimate contact with more and more rollers carrying load until a ratio of thrust-to-radial load is reached where all rollers are under load 360 degrees around the circumference of the bearing. This occurs when $F_a = 1.91\ F_r \tan \alpha$, or for contact angles between 10 and 30 degrees, the thrust would range from approximately ⅓ to 1⅛ times the radial load.

When considering a 2-row tapered roller bearing under combination radial and thrust loads the problem becomes a little more complex. For pure radial loads each row generates its own opposing thrust load to meet the basic practical requirement, $F_a = 1.25\ F_r \tan \alpha$. When, in addition to the radial load, a thrust load is applied, one row of rollers begins to carry more load while the other row is relieved of load. At the point where $F_a = 1.91\ F_r \tan \alpha$, one row commences to carry no load and the other row is carrying load 360 degrees around its circumference. At this point the unloaded row has no

Figure 14 — This bearing with O-ring seals would permit both axial movement and misalinement without leakage.



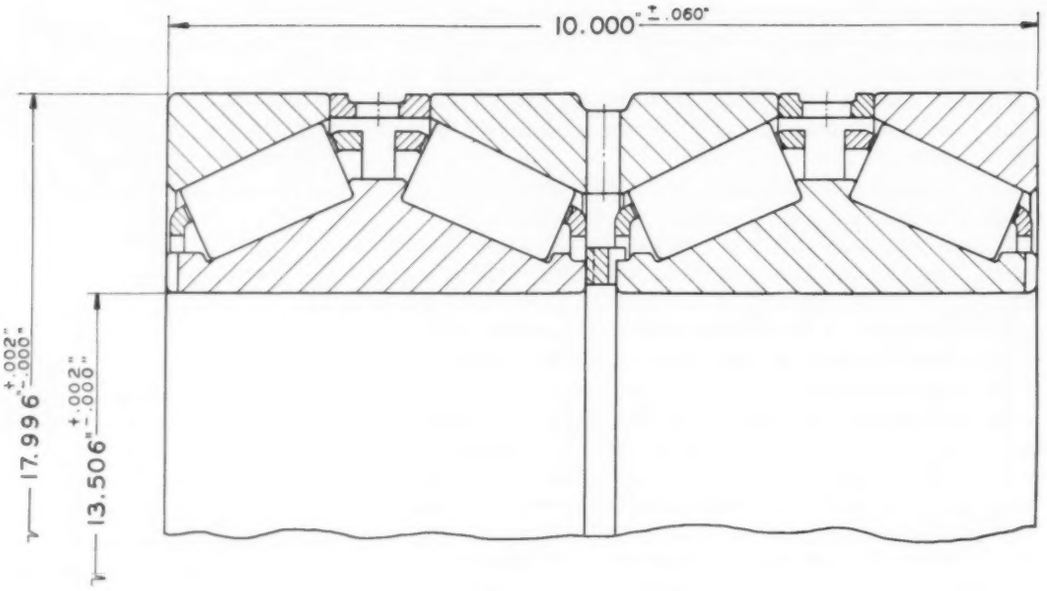


Figure 15 — Oftentimes one row of a standard 4-row, tapered roller, work roll neck bearing takes 80 per cent of a combined radial-thrust load.

function. The 2-row bearing then operates in exactly the same way as a single-row bearing and with the same capacity.

Applying this to the 4-row tapered roller bearing, pure radial load would be distributed evenly over 4 rows. As the thrust-to-radial-load ratio is increased, the load gradually shifts from four rows to two rows until a point is reached where only two rows carry the total radial and thrust load. With the ideal bearing these two rows would split the total radial and thrust loads 50-50. This is not the normal case in practice since the tolerances of the bearing, chock and roll neck plus the fact that the loose neck fit causes uneven wear of the roll necks, bearing bores and bearing spacers makes it rather difficult to asume that the load will be so evenly distributed. The problem is further complicated by deflection of rollers, rings, and spacers under load. Even before getting into operation, the tightening of end cover bolts on the chock can cause distortion of the rather light cup spacers. This will upset the load distribution within the bearing. Some mills use torque wrenches on these bolts to prevent this from taking place.

With so many things affecting the load distribution, it is not unreasonable to visualize the worst case where four rows would carry pure radial load in some load pattern, and, as the thrust-to-radial-load ratio is increased, one row carries the thrust load until a point is reached where the total radial and thrust load on the bearing is carried by this one row. This might be one of the many causes of quick, drastic failures of work roll bearings.

Work roll bearings must operate within these best and poorest extremes but where? It is the writer's opinion that because of the numerous factors affecting load distribution including the thrust loads generated by the normal operating condition of a mill, two rows of rollers in the held or thrust side work roll bearing carry the lion's share of the total radial and thrust loads and that these loads are not carried 50-50 but more on the order of 80-20, on the average.

This hypothetical load distribution within a 4-row tapered roller bearing suggests a new work roll bearing design, Figure 16, that may permit increased life within the same boundary dimensions as the standard design. By replacing the outside rows of tapered rollers with cylindrical rollers and relieving the outside diameter of the double cup or outer ring of the remaining two center rows of tapered rollers, a design is achieved wherein the thrust and radial loads are carried independently of each other, i.e., the radial bearing is not affected by thrust loads nor is the thrust bearing affected by radial loads. Adjustment of cup and cone spacers is not required for proper operation of the bearing. The only function of the cone spacer is to preclude preloading of the two rows of tapered rollers against each other in assembling on the roll neck.

Assuming that this bearing is made within the same boundary dimensions as the 13½-in. bore bearing shown in Figure 15, that the two rows of tapered rollers

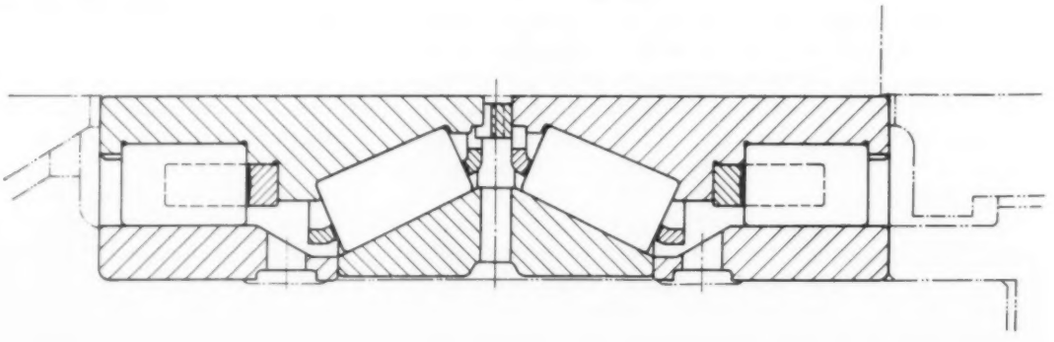


Figure 16 — This proposed work roll bearing design is such that the cylindrical rollers take no part of thrusts and the tapered rollers take no part of radial loads. This independence of rollers should improve bearing life when their thrust-to-radial load ratios are between 0.33 and 2.8.

have the same geometry as the standard bearing, and that it has the same 80-20 load distribution; the new bearing can be expected to give a longer life than the standard provided the ratio of thrust-to-radial loads lies between 0.33 and 2.8. In other words, if a work roll bearing operates under a radial load of 12,000 lb, the expected life of the new bearing would be greater when the mill thrust loads range between 4000 and 33,600 lb. For a radial load of 24,000 lb the thrust must be between 8,000 and 67,200 lb, etc., if increased life is to be had. At the same time the standard work roll bearing would have a longer expected life when the ratio of-thrust-to-radial loads is below 0.33 or above 2.8. It is the writer's opinion that the normal thrust-to-radial-load ratios found in a mill would be within the range of 0.33 to 2.8.

Perhaps this presentation of a new work roll bearing, Figure 16, design is premature since it has not been proved in a mill. However, 13½-in. bore bearings of the new design are in production and are to be tested in the near future.

SUMMARY

Having established the merit of the tapered bore, Multi-Row cylindrical roller bearing in actual mill operation over the last 10 years, advantage has now been taken of the versatility of this design to employ it in custom mountings to suit each particular rolling mill need. In brief, the following points have been discussed:

1. The tapered bore, tight neck fit multi-row design including such refinements as the sine bar and stand-off gages.
2. The straight bore, loose neck fit multi-row design with spiral bore grooves to preclude roll neck and bearing bore wear in mills not requiring the very close accuracy afforded by the tight fit design.
3. Standardization of ratings for roll neck bearings.
4. The extended inner ring multi-row for improved performance in multi-strand, high-speed rod mills.
5. The adaptability of the multi-row to changeover designs.
6. A new O-ring seal design that has possibilities.
7. A proposed work roll bearing design for longer average life.

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Discussion

PRESENTED BY

HARRY D. ROBB, Division Manager, Timken Roller Bearing Co., Pittsburgh, Pa.

E. C. DENNE, Jr., Manager, Rolling Mill Dept., SKF Industries, Inc., Philadelphia, Pa.

Harry D. Robb: Perhaps you might be interested in knowing how other people have attacked the roll neck wear problem without the necessity of machine work and additional bearings. I would like first to say that the mill; shown in Figures 7 and 8, was built in 1933, and according to our records there have been 12 bearings, including the original bearings, purchased for that mill. Today we make a better bearing than we did 30 years ago. The bearing that we would recommend today would have at least twice the life of the bearing used on the present mill. Therefore it is not a question of life, nor is it a question of wear on the bearing but wear on the roll necks.

One of the bearings that we have today to minimize that condition is the phosphated bearing. We now phosphate the bore of the bearing to minimize scoring. This will not eliminate it entirely but will reduce neck wear.

Now other methods have been used to eliminate wear, such as coating the necks at periodic intervals with special lubricants that prevent dry necks. However, if the roll neck wears to the extent as discussed in this paper of over 0.2 some other remedies have to be used. Two things have been done with such excessive wear. One of them is to furnish bearings with a smaller bore. In this case we could make a bearing with a ¼ in. smaller inside diameter. There have been other cases where the necks have been welded to the original dimensions.

Some mills have eliminated neck scoring by drilling a lubrication hole through the neck to the contact surface between the bearing and the neck and tying it in with the existing lubrication system. This method was proved entirely satisfactory.

We all know that it is not desirable to put any antifriction bearing on a rotating member unless it is put on with an interference fit, either with a tapered arrangement such as shown in this paper or by a press fit. For economical reasons the industry has not found it desirable on the slower speed mills to use interference fits. As speed and load increases, a corresponding increase in neck scoring will occur. Many are operating 4-high mills from 3000 to 7000 fpm with no neck scoring on the work rolls. This is due to the fact that work rolls operating at these speeds are changed so frequently that the lubricant between the bore of the bearing and the neck does not squeeze out. When bearings remain on rolls for a long period of time, the lubricant between the bearing and neck will squeeze out resulting in a dry neck and eventual neck scoring. This can be eliminated either with rolls drilled for lubrication or tapered bore bearings.

I want to comment on grooving of bearings. On the bearings that were shown as manufactured in England, a similar arrangement has been tried in this country by grooving the roll neck itself. The results have been unsatisfactory. However, it would be interesting to obtain a future report on the performance of the English manufactured grooved bearings.

The other comment that I would like to offer is in regard to the combination straight bore tapered roller bearing. Bearings of this general type were built and put in service as early as 1933. This design did not work out satisfactorily. However, there was one exception to the bearing that was built in 1933 as compared with the one discussed in this paper. In this new bearing, clearance is shown between the cup or outer race and the chuck. I do not know what this amounts to, whether it is 0.005, 0.010, 0.015 or some other amount. With sufficient clearance the tapered bearing should not

carry any radial load. If the clearance is small, the cup will expand under thrust load and meet the chuck bore resulting in a radial load on the bearing. If the clearance is large and the cup section is heavy enough to withstand the imposed thrust load, it is questionable as to whether enough thrust capacity can be built into a bearing within the space limitations. However, I am glad to find out that some of these bearings are now being manufactured. It will be interesting to obtain a report on their performance.

E. C. Denne, Jr.: Actually I did not mean to imply that there was any problem with bearing capacity in the changeover from 4- row tapered roller to the multirow cylindrical bearings on the 20 and 48 x 84-in. temper pass mill. The main problems as outlined in the paper were severe roll neck wear due to the loose neck fit with resultant mill vibration at higher speeds, sealing problems resulting from the eccentricity caused by roll neck wear, and strip chatter problems. Mr. Robb is absolutely correct in that bearing capacity was not a problem. Life of the 4-row tapered roller bearings as supplied by two different manufacturers had been quite satisfactory.

There is one question which I wish to ask Mr. Robb concerning the phosphate treatment of bearings. We found from laboratory tests that phosphate treatment of the rollers and roller raceways, the surfaces upon which the rollers ride, reduces bearing life. What have been your findings in this connection?

Harry D. Robb: Our home office in Canton, Ohio, tells me that the tests they have conducted indicate no reduction of life in the bearings. We have some phosphated bearings that have been in operation on backup rolls of a hot strip mill for six years.

In fact, at present all of our railroad bearings, which we call our all purpose bearings, are completely phosphated; but at present the phosphated bearings we offer to the steel industry are 4-row bearings with only the bores phosphated. We propose, when the necessary equipment is provided, to completely phosphate all of our larger bearings. Our aim is to prevent corrosion and to aid in the elimination of neck scoring by this process. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer*, a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. The papers may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. All correspondence concerning price, ordering and so forth should be directed to the preceding source.

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(Abstract of No. 1120 J.I.S.I., 1957, Nov., p. 249: Characteristic parameters defining O.H. productivity are discussed, as are the efforts of the type and arrangement of various components on them. These factors are most easily studied with small-scale models, which are essential for design.)
(Abstracts of Nos. 1124 and 1125 J.I.S.I., 1958, Aug., p. 365b: V—Model studies of a single-uptake furnace show that the uptake width should be 50–60 per cent (preferably 50 per cent) of the chamber width, and the length should be one-third of the chamber width. In the central uptake design, the width should be four-sevenths of the head width, but equal to it in the spread uptake design.
VI—Optimum head dimensions derived from model studies are given. Side-wall wear may be reduced without affecting the incoming air-flow by lowering the head roof or the end wall to the end.)
(Abstract of 1126, J.I.S.I., 1958, Oct., p. 213a: Model studies show that the best position for the burner jet is inserted at a quarter of the chamber width and set at a height of 30 per cent of the furnace width at an inclination of 12 per cent. The effects on flow of twin jets are examined, and the flame lengths are found to be shortened by increasing the jet fluxes and slight convergence of the burner directions.)

An Analysis of the Mechanics of Cold Strip Rolling

by Donald Jortner, Allegheny Ludlum Fellow in Mechanical Engineering,
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and Carl F. Zorowski, Assistant Professor of Mechanical Engineering,
Carnegie Institute of Technology, Pittsburgh, Pa.

The power requirements of any given rolling mill for reducing strip of any material and dimensions can be predicted by application of the experimentally-proven theory presented herein . . . . this theory takes into account the elastic deformation of the strip and rolls and the effect of applied tensions as well as the plastic strip deformation . . . . it has applications in the investigation of causes of non-uniform strip gage and roll fatigue failure . . . .

THE theory of strip rolling is far from being advanced to a state permitting an exact mathematical analysis. The development of a better mathematical model is important since it may eventually lead to the elimination of expensive testing of proposed new equipment to accurately predict its capabilities. Also, the increasing use of relatively unfamiliar metals in strip poses a problem since their behavior in cold rolling is not generally predictable from existing empirical data.

This paper presents an analysis of the mechanics of cold strip rolling which is more refined in many respects than previous ones. It can be applied to any type of strip and rolls whose mechanical properties are known. The solution of the roll flattening and elastic strip deformation effects are advanced to exact or nearly exact solutions. The development resulted from doctoral thesis research recently completed at Carnegie Institute of Technology.

The mathematical derivations and convenient computer programs included in the thesis are not presented in this paper. Rather, a description of the methods used is given. Also included are results for several sample cases and further applications of the theory to related problems. If the mathematical description and derivations of the method are required, there are a limited number of copies of the thesis available from the Mechanical Engineering Department, Carnegie Institute of Technology, Pittsburgh, Pa.

DESCRIPTION OF APPROACH

Throughout this work the assumption will be made that the lateral spread in cold strip rolling is confined to narrow zones near the edges. This reduces the problem to one of plane deformation. The assumption is probably quite accurate except in the two edge regions.

The analysis for the deformation of the roll surface due to an arbitrary pressure distribution on the roll is developed first. For any specified surface pressure distribution the surface shape is determined. If the shape of the roll surface is specified, a revised pressure distribution in the strip can then be calculated. The analysis of the strip makes use of a variation of Von Karman's friction hill theory plus a nearly exact analysis of the elastic zones in the strip. Finally, the two solutions (one supplying the roll surface shape for a given pressure distribution and the second supplying the reverse) are used alternately in an iteration procedure which converges to an equilibrium pressure distribution and contact arc shape. Other results which are obtained are the rolling torque, length of the arc of contact, and amount of roll flattening.

For a given problem to be solved, the only information required is the mechanical properties and dimensions of the materials involved, the applied front and rear tension, and the average coefficient of friction between rolls and strip. Unfortunately, very little quantitative information is known about the variation of friction in the arc of contact in rolling. For this

reason, an approximate average value is used in all calculations. This is taken from the experiments of Whitton and Ford in 1955.[1]*

The entire analysis has been programmed for solution on the IBM 650 digital computer. When the above data is supplied to the computer, the iteration procedure is carried out automatically. The computer time required for a given rolling case is 40 to 120 min depending on the size of the angle of contact. However, this time could be reduced to the order of one minute by the use of a faster computer.

The mathematical model used for the contact region is shown in Figure 1. The region of contact in the strip is represented by three zones, the elastic compression zone, the plastic zone, and the elastic recovery zone. In the analysis, it is assumed that the zones are bounded by vertical plane sections. Also, the assumption is made that slipping occurs between the strip and the rolls on the entire arc of contact. This is not strictly true, but is a good approximation for cold rolling. This assumption allows the designation of a single neutral point on the arc. Theoretically, this is the point at which the friction changes direction and there is no relative motion between strip and rolls.

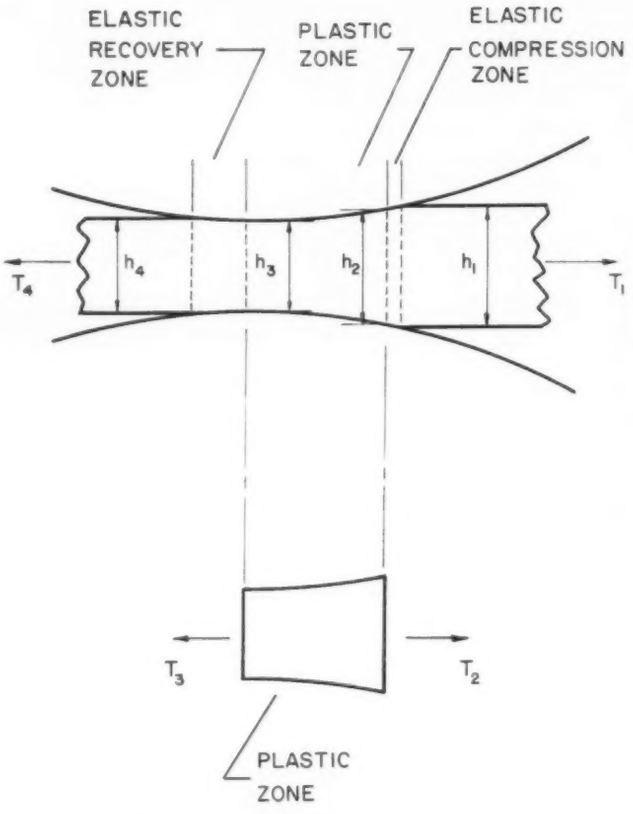


Figure 1 — The mathematical analysis assumes that the zones are bounded by vertical plane sections and that slip between the strip and roll occurs over the entire contact arc except at a single point designated the neutral point.

ROLL DEFORMATION

In the past, the analysis of roll deformation was hampered by the extensive computing required. Before the advent of digital computers, the only practical solutions were approximate ones.

The best known solution for roll deformation is the one proposed by Hitchcock.[2] In his work it is assumed that the pressure distribution is of a form which produces a circular arc of contact. It would seem from minimum strain energy considerations that this assumption would overestimate the effect of roll deformation in increasing the rolling load. In 1951, Keller[3] showed that for a given length of the arc of contact, the effect of a variation in roll shape on the rolling load is quite small. However, it is important to note that any change in length of the arc has a large effect on the rolling load. Therefore, in this analysis a more exact solution is used for roll deformation in order to determine the contact length accurately.

This roll deformation analysis uses the exact pressure distribution on the roll surface. It requires the use of an electronic computer unless one is willing to use a very coarse mesh in the finite difference calculations. In this treatment, the elastic mathematical model chosen is a cylinder in plane deformation with diametrically opposed surface loading. Placing the balancing force at the opposite end of the diameter from the contact arc most closely approximates the conditions found in a 4-high mill where the backup roll supplies the balancing force. However, the contact arc is quite small compared to the diameter of the roll (the contact angle rarely exceeds six degrees in cold rolling). This would seem to indicate that a difference in the location of the balancing force would not have an appreciable effect on the radial deformation of points on the contact arc. The method would then also apply to 2-high mills and cluster mills. In addition it is assumed in this analysis that the tangential shearing stresses on the roll surfaces have a negligible effect on the radial deformations.

First, an influence function is obtained which gives the radial deformation at any point on the surface of the cylinder due to radial point loads at the ends of a diameter. In Figure 2, the behavior of this function over a quarter cylinder is shown. In this figure, u is the radial deformation, E is the modulus of elasticity, P is the point load, ν is Poisson's ratio, and θ is the angle between the loaded diameter and the surface point in question.

Naturally, this influence function has singularities directly under the concentrated loads. This difficulty is eliminated by replacing the point load by a pressure on a differential arc length and integrating the influence function over a small finite angle. This results in an influence function which gives the radial deformation of any surface point due to equal loads distributed uniformly over small finite angles at the ends of a diameter. This influence function is shown in Figure 3 where α represents half the angle over which the load is distributed, a is the roll radius, and p is the radial pressure.

The entire pressure distribution which makes up the rolling load can be represented in finite difference notation as the sum of a number of adjacent uniformly distributed loads, each acting over a small angle. The finite difference angle used in the computations is 0.1 degree. This allows 30 to 60 finite difference areas on the arc of contact in a given rolling case.

The total radial deformation at any point due to an arbitrary pressure distribution on the arc of contact

* Numbers refer to references in bibliography at end of paper.

can be found by the superposition principle. This then is the finite difference form of the exact solution for roll deformation. If the finite difference angle were to approach zero as a limit, the sum would approach the integral and the solution would approach the true exact solution.

STRESS DISTRIBUTION THROUGHOUT THE STRIP

In the region of contact in the strip, there is an elastic zone on both sides of the plastic zone. In Figure 1, it can be seen that T_1 and T_4 are applied tensions on the strip. The first step in finding the stress distribution throughout the strip is to obtain a solution for the two elastic zones. This will not only determine the surface pressure distributions on the elastic zones, but also determine the values of T_2 and T_3 which are the horizontal tensions at the plastic-elastic boundaries. These quantities must be known in order to analyze the plastic zone.

The shape of the roll surface has already been determined from the roll deformation analysis. Next, the minimum strip height which occurs at point 3 (the plastic-elastic recovery zone boundary) is determined from the plastic yield criterion for the strip together with elastic stress-strain relations. This completely specifies the strip height distribution. The yield criterion used here is the maximum shear strain energy theory, which is credited to R. von Mises[4] and H. Hencky.[5] This can be simplified for plane deformation to the well known form in which yielded material satisfies the condition that the constrained yield stress equals the difference between the vertical and horizontal pressures.

With the applied tensions known, it is possible using elastic stress function theory to obtain the finite difference form of the exact stress distribution in the elastic zones. This determines the horizontal tensions at the elastic-plastic boundaries for use in the plastic analysis.

The plastic analysis used here is an adaptation of Orowan's homogeneous theory.[6] It was shown by Bland and Ford[7] that the errors in the assumption of homogeneous plastic compression for cold rolling are likely to be less than the errors encountered in specifying the physical properties of the materials. The only change made here in Orowan's theory is the adaptation to the noncircular arc of contact which actually exists. There are two finite difference equations used in the plastic zone. The difference between them is in the direction of the frictional force on opposite sides of the neutral point. The calculations are begun at both plastic-elastic boundaries, and the neutral point is determined where the two solutions give equal roll pressures.

To summarize the assumptions inherent in the homogeneous theory of plastic stresses, they are:

a. The yield criterion is the maximum shear strain energy theory.
b. There is no lateral spread of the strip (i.e. plane deformation).
c. The stress is uniformly distributed over a vertical section.
d. The vertical and horizontal stresses in the strip are equal magnitude to the principal stresses.

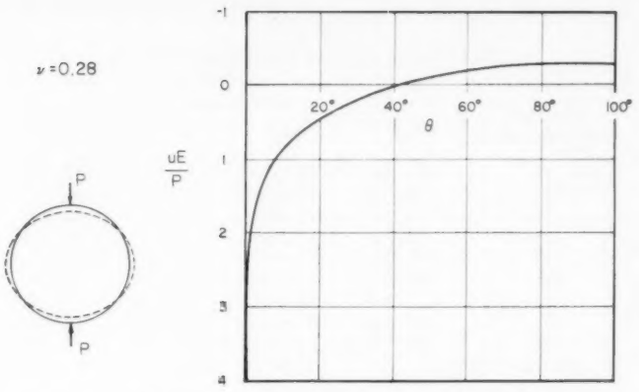


Figure 2 — This curve shows the radial deformation that results when a roll is subjected to two diametrically-opposite, concentrated, compressive loads.

e. The plastic region extends everywhere between the plastic-elastic boundaries.

As mentioned in the introduction, not very much is known about the mechanism of friction in the arc of contact. In much of the previous work in rolling theory, the value of the coefficient was chosen to give the best correlation with experiments. However, this practice tends to mask any systematic deviations in the theory. Therefore, the value used in this work is taken from recent experimental results on the subject.[1] These results seem to indicate that for steel on steel with soluble oil as lubricant, the average coefficient of friction is in the range 0.055 to 0.060. A value of 0.055 is used in the sample cases.

The constrained compressive yield stress curve of the strip can be measured experimentally either directly or by mathematical conversion from a simple tensile test. The curve is put into the computer as a cubic equation which gives the yield stress as a function of strip height.

SUCCESSIVE APPROXIMATION PROCEDURE

The equilibrium conditions of roll shape and pressure distribution are obtained by an iteration procedure.

Figure 3 — This radial deformation curve is for a roll subjected to a pressure applied to two small arc lengths, diametrically-opposite to each other on the roll's perimeter.

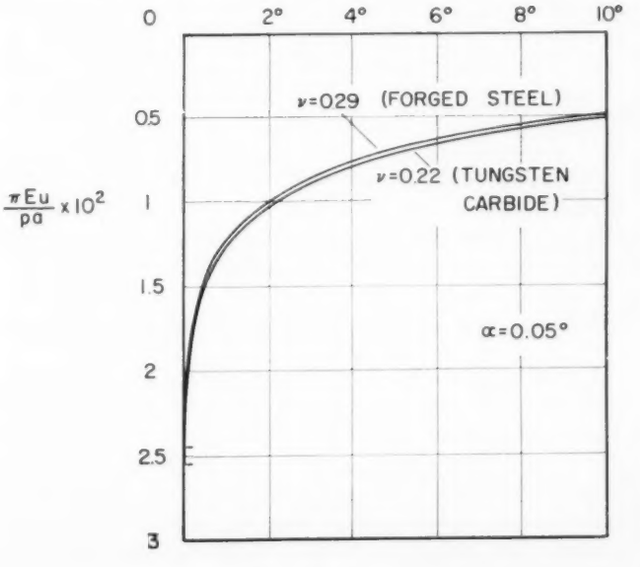


TABLE I
Yield Stress in Plane Compression, Psi

Per cent deformation	Coil number			
	2	3	5	6
0	23,800	27,000	22,000	27,000
10	58,000	60,600	60,000	60,600
20	72,000	76,400	73,600	73,600
30	79,600	85,000	81,400	82,200
40	85,400	90,600	87,200	88,000
50	90,000	94,400	90,000	92,400
60	94,200	96,600	95,600	95,600
70	97,400	97,600	98,200	97,600
80	100,400	98,400	100,200	99,400

Starting with the undeformed roll, the strip is analyzed to find a starting pressure distribution. Then this pressure distribution is used in the roll deformation analysis to find the deformed roll shape. This procedure is continued until the shape and pressure distribution do not change appreciably upon further iteration. This is the equilibrium state. The other important results such as torque, roll flattening, etc. are simple to obtain from the pressure distribution and/or geometry of the system.

EXPERIMENTAL RESULTS OF HESSENBERG AND SIMS

The experimental results published in 1951 by Hessenberg and Sims[8] will be used here as a check on the limits of accuracy of the theory. The experiments appear to have been performed under extremely accurate conditions. The work was done on a 10 in. x 10 in., 2-high cold strip mill. Two thicknesses of strip were rolled giving roll radius per initial strip thickness ratios of approximately 80 to 1 and 130 to 1. The strips were of commercial quality rimming steel. The thicker strip had a nominal gage of 0.063 in. and was annealed. It was rolled in the tests to nominal 30 and 50 per cent reductions under varying tension conditions. The thinner strip had a nominal gage of 0.038 in. and had been previously cold rolled to 40 per cent reduction. It also was rolled in the tests to nominal 30 and 50 per cent reductions under varying tension conditions. The yield stress table of the materials was measured by the method described by Ford[9] and is reproduced in part in Table I.

The tests were performed using six coils of strip. A yield stress curve was determined for each one. Coils 2, 3, 5, and 6 were used for the tests mentioned above. Coil 4 was used for a repetitive test which gave an estimate on the experimental accuracy. The results of this indicate limits of plus or minus 3 per cent on load and 2.5 per cent on torque. A detailed description of the other test conditions is given in reference (8).

COMPARISON OF THEORY WITH EXPERIMENT

In the published experimental results of Hessenberg and Sims, a large number of cases were considered. The experiments were designed to show the effects of variation of applied tension on the rolling load and torque. Sixteen cases are used here for purposes of comparison. There are four from each of the four groups of nominal reductions. In each group the cases are chosen to give examples of varying magnitudes and ratios of front and rear tensions.

TABLE II
Calculated and Experimental Results for Annealed Mild Steel
Coil 2. Nominal reduction 30 per cent

	2a	2b	2c	2d
Initial strip thickness, in.	0.0643	0.0645	0.0645	0.0642
Final strip thickness, in.	0.0455	0.0455	0.0456	0.0453
Average applied front tension, psi	3600	12,000	21,600	23,000
Average applied rear tension, psi	0	12,600	6000	12,600
Experimental load, lb per in.	27,000	22,600	23,000	20,800
Calculated load, lb per in.	27,600	21,850	22,550	20,350
Error in load, per cent	+2.2	−3.3	−2.0	−2.2
Experimental roll torque in.-lb per in. of strip width	2780	3340	1400	2160
Calculated roll torque, in.-lb per in. of strip width	2860	3360	1420	2080
Error in torque, per cent	+2.9	+0.6	+1.4	−3.7
Other calculated results				
Roll flattening per roll, in.	0.00206	0.00166	0.00165	0.00150
Angle of contact, degrees	4.1	4.1	4.0	4.0
Per cent of angle due to roll deformation	9.8	9.8	7.5	7.5
Per cent of load due to roll deformation	11.6	10.2	8.9	8.9
Coil 3. Nominal reduction 50 per cent				
	3a	3b	3c	3d
Initial strip thickness, in.	0.0633	0.0651	0.0651	0.0646
Final strip thickness, in.	0.0325	0.0327	0.0320	0.0327
Average applied front tension, psi	15,800	15,600	8600	39,800
Average applied rear tension, psi	6200	12,400	18,600	18,600
Experimental load, lb per in.	31,600	30,000	29,000	25,000
Calculated load, lb per in.	33,700	30,950	26,800	23,850
Error in load, per cent	+6.6	+3.2	−7.6	−4.6
Experimental roll torque, in.-lb per in. of strip width	4800	5440	6640	3960
Calculated roll torque, in.-lb per in. of strip width	4940	5340	6420	3870
Error in torque, per cent	+2.9	−1.8	−3.3	−2.3
Other calculated results				
Roll flattening per roll, in.	0.00238	0.00204	0.00180	0.00157
Angle of contact, degrees	5.1	5.2	5.2	5.0
Per cent of angle due to roll deformation	7.8	7.7	7.7	8.0
Per cent of load due to roll deformation	11.2	12.2	11.8	9.2

The elastic properties of the strip and rolls used in the analysis are as follows. For the roll, a modulus of elasticity of 30,000,000 psi and Poisson's ratio of 0.29 are used. For the mild steel strip, values of 29,500,000 psi and 0.287 are used. These values were obtained from reference (10).

In Tables II and III, the comparison of vertical rolling load and torque per roll is shown along with a number of other results of the theoretical solution. The average error in the load is −4.3 per cent; in the torque it is +3.1 per cent. The maximum error in the load is 13.0 per cent; in the torque it is 10.8 per cent. All but one of the loads are within 7.6 per cent, and all but two of the torques are within 4.2 per cent. It is difficult to evaluate these magnitudes, since the experimental error is of the order of 3 per cent. How-

TABLE III

Calculated and Experimental Results for Pre-rolled Mild Steel Coil 5. Nominal reduction 30 per cent

	5a	5b	5c	5d
Initial strip thickness, in.	0.0382	0.0389	0.0383	0.0383
Final strip thickness, in.	0.0265	0.0262	0.0262	0.0261
Average applied front tension, psi	11,000	76,000	23,600	40,200
Average applied rear tension, psi	0	11,400	11,600	23,400
Experimental load, lb per in.	33,600	32,000	29,000	21,800
Calculated load, lb per in.	32,600	30,350	26,900	20,450
Error in load, per cent	−3.0	−5.2	−7.2	−6.2
Experimental roll torque, in.-lb per in. of strip width	2500	3540	2400	2020
Calculated roll torque, in.-lb per in. of strip width	2770	3830	2500	2040
Error in torque, per cent	+10.8	+8.2	+4.2	+1.0
Other calculated results				
Roll flattening per roll, in.	0.00244	0.00230	0.00187	0.00154
Angle of contact, degrees	3.4	3.5	3.3	3.2
Per cent of angle due to roll deformation	14.7	14.3	12.1	9.4
Per cent of load due to roll deformation	19.8	19.6	15.3	10.6
Coil 6. Nominal reduction 50 per cent				
	6a	6b	6c	6d
Initial strip thickness, in.	0.0385	0.0385	0.0385	0.0387
Final strip thickness, in.	0.0184	0.0185	0.0176	0.0182
Average applied front tension, psi	8400	8400	21,800	42,200
Average applied rear tension, psi	0	13,000	13,000	23,800
Experimental load, lb per in.	45,600	40,800	37,400	29,600
Calculated load, lb per in.	44,250	38,450	36,050	25,750
Error in load, per cent	−3.0	−5.8	−3.6	−13.0
Experimental roll torque, in.-lb per in. of strip width	5060	5640	4940	4140
Calculated roll torque, in.-lb per in. of strip width	5110	5640	4830	4280
Error in torque, per cent	+1.0	0	−2.2	+3.4
Other calculated results				
Roll flattening per roll, in.	0.00334	0.00264	0.00250	0.00176
Angle of contact, degrees	4.3	4.4	4.3	4.2
Per cent of angle due to roll deformation	14.0	15.9	11.6	11.9
Per cent of load due to roll deformation	18.9	22.1	18.2	14.1

ever, it is felt that this method is at least as accurate and considerably more general than other methods in use.

It is quite likely that the most room for improvement in the over-all analysis is in the determination of the surface friction coefficient. Until more is learned about the mechanism of friction in the arc of contact, it is doubtful that much further increase in accuracy can be obtained.

EFFECTS OF ROLL FLATTENING

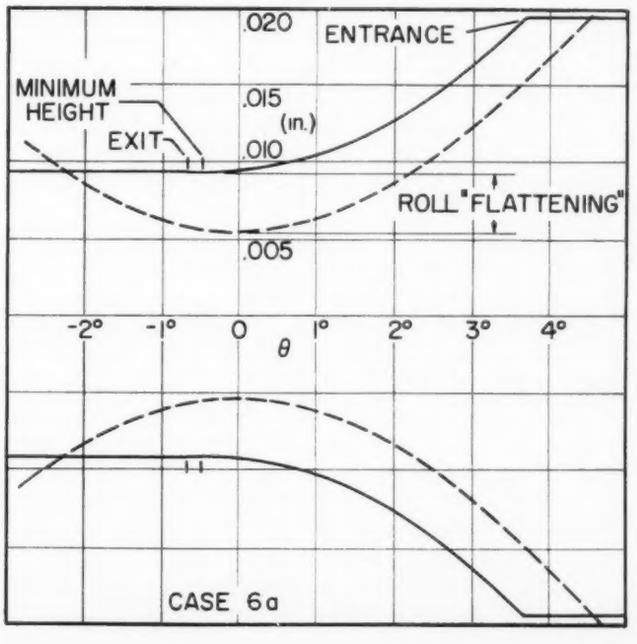
The roll flattening is a measure of the amount of radial deformation per roll at the point of minimum strip thickness. Stating this differently, it is a measure of the amount that the position of each roll must be adjusted due to roll deformation in order to produce strip of the required thickness.

In Tables II and III the magnitude of the roll flattening is presented for each of the 16 cases considered. It is found that the calculated roll flattening is essentially a linear function of the total rolling load for these cases. It is reasonable to expect that for a given rolling load the flattening would be to some extent inversely proportional to the length of the arc of contact. However, evidently the angles of contact considered in these four groups of examples are not varied enough to destroy the linear relationship.

In Figure 4, the magnitude of the roll flattening is compared to the strip dimensions for a representative case (6a). It is seen that although the flattening is quite small compared to the diameter of the roll, it can be quite large compared to the half strip height. Also, it should be noted that this example case is for mild steel strip. The deformation for high yield strength strip becomes more severe. In practice the roll flattening effect sometimes requires an initial interference setting of the rolls in order to have the flattened rolls deliver the correct gage strip. In Figure 4 the solid curves represent the deformed equilibrium contact region for case 6a. The dotted curves represent the undeformed position of the roll surfaces. In other words, if the strip is removed from between the rolls, they would assume the dotted curves shape. The dotted curves do not appear circular because of the large difference between the vertical and horizontal coordinate scales.

Figure 5 shows the comparison between the predicted pressure distribution for the equilibrium state and the distribution which would occur without any roll deformation. This figure also represents case 6a. The percentage of the rolling load due to roll deformation is given for each of the 16 cases in Tables II and III. These results indicate that a percentage increase in the contact angle due to roll flattening produces a larger percentage increase in the rolling load. This is predictable from the shape of the pressure distribution. If the shape is approximated by a triangle on top of a rectangle of equal

Figure 4 — This magnified scale drawing of case 6a, which is representative, shows the relative magnitude of roll flattening with respect to strip dimensions.



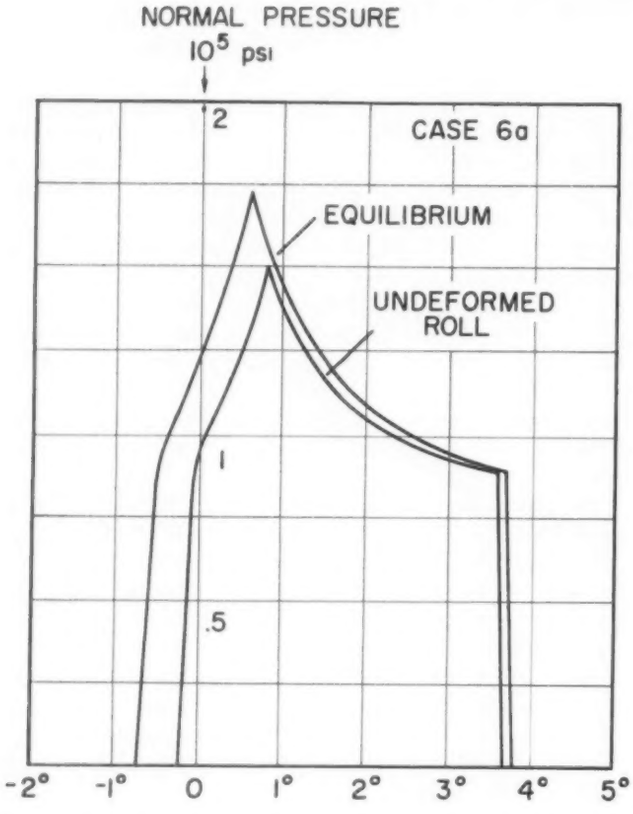


Figure 5 — These curves show the comparison between the predicted pressure distribution for the equilibrium state and the distribution which would occur without any roll deformation.

base, it can be shown that an increase in the length of the base produces a larger percentage increase in the area of the figure. It should be noted that the sides of the triangle do not change slope, thus producing an increase in the height of the peak as well as the length of the base.

It is quite common in the rolling of strip to encounter lateral nonuniformity of gage (edge taper). It is found in practice that the gage is relatively uniform across the strip except for a sudden taper which occurs within about an inch of each edge. Since the effect is confined to local zones near the edges, it is very unlikely that it has a great deal to do with the bending of the roll on its axis. From the physical characteristics of the system, it appears that a major cause of edge taper is the decrease in roll flattening near the edges which results from a dropping off of the pressure curve where lateral spread occurs.

When the rolls are appreciably wider than the strip being rolled, it can be assumed that at the ends of the rolls there is no appreciable flattening effect. Therefore, at the ends of the rolls the minimum clearance between rolls is smaller than the minimum strip height h_3. A diagram of this effect is shown in Figure 6. The difference in the clearance is equal to the amount of adjustment made in the roll settings to account for roll flattening. To state it differently, if the strip were removed from between the rolls, the clearance at the center would reduce and become equal to the clearance at the ends except for the difference due to roll crown.

As mentioned previously, sometimes in practice the unflattened clearance must actually be made negative in order to produce the correct size strip. A negative setting produces an additional side effect in that the measured rolling load increases due to the rolls contacting each other without actually putting any more work into deforming the strip.

It would require a very difficult three dimensional analysis to obtain an accurate solution for the amount of strip taper. However, an upper bound on the taper is just equal to the difference between the flattened and unflattened clearances or twice the roll flattening per roll. The upper bound can never be reached, since it would require all of the change in clearance to occur in the area covered by the edge of the strip. Actually, it might be a good approximation to assume that half of the change in clearance occurs outside of the strip edge. Then the strip taper would be approximately equal to the flattening per roll.

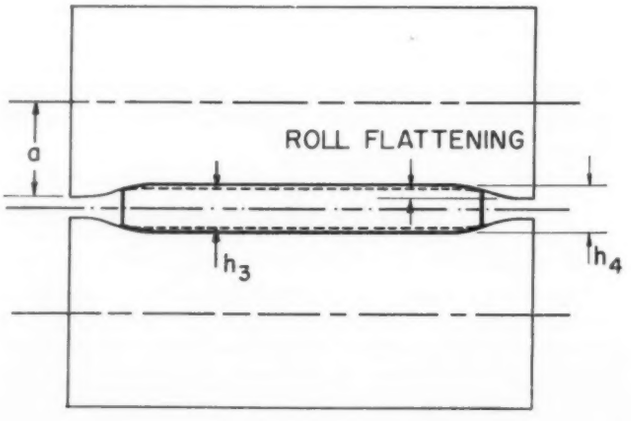
MINIMUM GAGE OBTAINABLE

If metal strip behaved as an ideal plastic, there would be no limit to the reduction obtainable in rolling. However, due to the elastic behavior of the strip, no further reduction in gage is obtainable when the entire region of contact becomes elastic. The strip is reduced in the elastic compression region and recovers the entire amount of reduction in the elastic recovery region. There is no plastic reduction in this case. The rolling load is then all due to elastic pressures. This would occur in a reversing mill when there can be no further change in roll setting without exceeding the allowable load for a mill. The page at which this phenomenon occurs is the minimum strip gage obtainable for this rolling load.

The allowable load for a mill is controlled by either the strength of the roll necks or the fatigue properties of the roll surface. The maximum allowable load is usually given in pounds per inch of width of the strip. The magnitude of the allowable load can be determined by analytical or experimental means.

The successive approximation analysis can be adapted to predict the minimum obtainable gage. In the computer program, the exit gage is specified equal to the entry gage. The plastic zone calculations are by-passed and it is specified that the yield criterion is satisfied at only one point. This is now the boundary of the two elastic regions. For a simple case, when the two applied

Figure 6 — This drawing, in an exaggerated way, shows the actual strip contact surface viewed from in front or behind the mill.



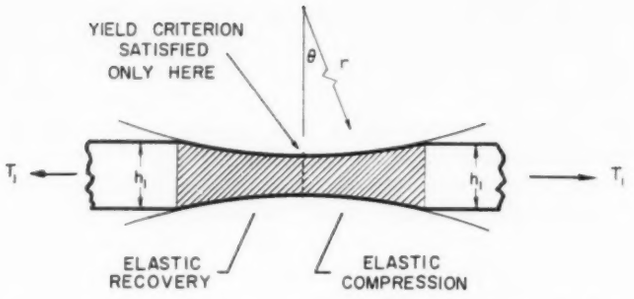


Figure 7 — No reduction of strip is had when the strip is not compressed beyond its elastic limit.

tensions are equal, the pressure and height distributions are symmetrical with respect to the line between roll centers, and the length of the two elastic regions are equal. Figure 7 is the diagram of the contact region for this case.

The fact that the yield criterion is satisfied at only one point shows that the rolling load for this model is the maximum load which can exist without any plastic flow. Physically, if the rolls were moved any closer together, the load would increase and there would be plastic flow.

For a specified value of the annealing gage for a given strip material, and for a rolling mill with specified roll dimensions and material, a curve can be obtained which shows the absolute minimum obtainable gage vs the rolling load. Also, for any given rolling load, this procedure could be used to investigate the relationship between the minimum obtainable gage and any of the system parameters (roll diameter, roll material, annealing gage, etc.).

The absolute minimum obtainable gage might not be the best limiting quantity to calculate, practically speaking, since it is generally approached asymptotically. For many purposes it might be more valuable to specify that the exit height is 0.001 in. less than the entry height. For this calculation, the plastic zone exists, although it is not necessarily large compared to the other two zones. The result obtained for this analysis is the minimum gage at which a reduction of 0.001 in. can be obtained without exceeding a specified load.

FATIGUE FAILURE OF ROLLS

In the process of deriving the roll deformation equations, expressions were obtained which indicate the complete state of stress for the entire roll surface. This would be quite useful in a fatigue analysis of the roll, since it would enable the analyst to determine the entire repetitive stress cycle which the roll undergoes.

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Discussion

PRESENTED BY

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R. A. PHILLIPS, Control Systems, Analytical Engineering Section, General Electric Co., Schenectady, N. Y.

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DONALD JORTNER, Allegheny Ludlum Fellow in Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

E. H. Forsstrom: A great deal more work should be done along these lines before we will really know all the answers of what goes on in the roll bite across the entire width of the strip.

R. A. Phillips: One of the criticisms of previous methods of calculating roll force and torque is that they may not be adequate for the extreme conditions of rolling found in the fourth and fifth stands of a tinplate mill where outgoing thicknesses may be 0.013 and 0.008 in. respectively. In the study of regulating systems it is necessary to calculate the small irregular disturbance relationships between tensions, thickness, neutral point location and roll force and torque.[1] Do the authors feel that their theory can be used with confidence for thin strip?

The second area of interest is that of calculation of mill spring. An article by J. D. Keller[12] gives measured values of spring on several U. S. mills. The author reports that about 20 per cent of the deflection of a typical 4-high mill is accounted for by deflection of housings and bending deflection of the rolls. The other 80 per cent is attributable to flattening of the rolls. I presume that this flattening takes place not only on the portion of the work roll which is in contact with the strip but also on the surfaces of the work roll and backup roll which are in contact. Have the authors attempted to calculate this total deflection and compare calculated to measured value?

J. D. Keller: The respects in which this paper is an improvement over any preceding work on the subject, are chiefly these two:

1. Account is taken of the actual initial and final curvature of the rolls at the place of contact with the strip.

2. The presence of elastic regions in the strip itself, at both ends of the contact length, is taken into account.

As to the first-named item, Hertz in his pioneer work on the contact of elastic bodies including cylinders, and after him Föppl, and also Belaieff, calculated as if the boundary of the elastic body were initially a plane surface, instead of curved, immediately at the place of contact.

The radial deformation of an elastic body, such as a roll, consists of two parts: (1) a concentrated high stress deformation not extending very far below the surface, and accounting for perhaps 15 per cent of the total (in a typical case) and (2) a low stress deformation diffused over the rest of the distance to the axis of the roll and making up the balance or about 85 per cent of the total radial deformation.

Föppl worked out the mathematics for the cylinder, taking account of the curvature of the boundary, as respects the deformation diffused over most of the radius, but when calculating the high stress deformation near the place of contact he apparently followed Hertz in treating the roll as if it were bounded initially by a plane surface.

Mr. Jortner has taken into account the effect of the curvature on the deformation near the place of contact also. He found, as might be expected, that the buttressing effect of the parts between the plane boundary and the curved boundary, alongside those elements which lie directly under the contact, would reduce the deformation. In other words, the true deformation is greater than that calculated according to Hertz or Föppl. A graph contained in his thesis but not in the present paper, shows that at the point of maximum deformation the difference is about 5 per cent.

Mr. Jortner should state whether this affects the contact length for a given total load; and if so, what is the percentage decrease or increase due to taking full account of the curvature.

T. T. Loo of Rensselaer Polytechnic Institute, in a recent ASME paper (No. 57-A-33), also considered the effect of curvature, and found, like Jortner, that the total radial deformation is increased thereby. Loo, following Hertz, used an elliptical pressure distribution curve instead of the peaked "friction hill" curve used by Jortner. The writer on working a numerical example from Loo's equations for conditions corresponding to contact of work roll on backup roll, found about 4 per cent increase over Föppl.

As to item (2), the writer in 1937 pointed out the existence of these elastic regions in the strip at each end of the length of contact of strip on roll. So far as known, Mr. Jortner is the first to give a full mathematical treatment including these regions. This is important in that it increases the contact length; and as those who have worked with the charts in Professor Trinks' *Roll Pass Design* (Supplement, Figures S4 and S61) well know, the effect of such an increase is cumulative and can sometimes result in a very large increase of the total rolling load.

It would seem, however, that an increase in the contact length due to item (2) may be at least partly counteracted by a probable decrease of the same due to item (1). Mr. Jortner should state, for a typical example, the change produced by each of the two factors and the net percentage change in the contact length.

The inverted application in the paper, of St. Venant's principle is, in the writer's opinion, deceptive. (This principle states that the manner of load application at a place on the boundary has negligible effect on the deformation at any considerable distance therefrom.) True, a difference in the location of the balancing force or reaction may not have an appreciable effect on the radial deformation of points on the contact arc *with respect to each other*—which is what Mr. Jortner is chiefly interested in—but it can have a decided effect on their total deformation referred to the roll axis. This means that Figure 7 of the paper applies to the work roll of a 4-high mill but is not correct for the backup roll, nor for a 2-high mill.

The nearest approach to conditions in backup rolls or in 2-high work rolls is J. H. Michell's case of the "heavy disk resting on a plane," where the reaction force is the weight of the disk, distributed over its area. According to the writer's calculation using Michell's equations in a typical example, the radial deformation of points on the contact arc, with respect to the roll axis, would be about 20 per cent less than when the reaction is at the opposite end of the diameter from the load application. In an actual backup roll, where the reaction is made up of shear forces not uniformly distributed over the cross section of the roll but maximum at the horizontal centerline, the reduction of radial deformation would probably be smaller than 20 per cent.

As to the minimum strip gage obtainable, Mr. Jortner seems not to be aware that as the screwdown pressure is continually increased, the thickness of the strip leaving the pass at first decreases rapidly, then slows to a minimum, and with further screwing-down the thickness actually *increases* regularly. This was shown mathematically by the writer some 20 years ago (in "How Thin Can Strip Be Rolled?" Blast Furnace & Steel Plant, October, 1937, pp 1110–1113, esp. Figure 3); has been amply confirmed in practice; and was restated with refinements by M. D. Stone (in Iron & Steel Engineer, 1953 and 1956) and again by K. Tong & G. Sachs (in Journal of the Mechanics & Physics of Solids, 1957, vol. 6, pp 35–46, esp. their Figure 6).

With reference to fatigue failure of rolls, it would be helpful if the author would plot the maximum shear stress found in his calculations vs depth below the contact surface, and also the *range* of reversed shear stress at various depths expressed in per cent of contact length or of roll radius.

Mr. Jortner seems to feel that, if only we knew with accuracy the coefficient of friction between the strip and the rolls, the problem of calculating rolling forces could be considered completely solved. At the other extreme is the opinion expressed by N. H. Polakowski that roll-pressure theories have extremely poor predictive value in the critical ranges, and are unreliable for design purposes; and that only experimental measurements under conditions approximating those of the actual rolling operation can be relied upon.

The writer would not go quite so far, but is certain that in view of the wide discrepancy between the calculated form of the curve of distribution of pressure (between strip and roll) and the results of the few actual

experimental determinations that have been made, the problem is far from solved. The classical pioneer tests by Siebel and Lueg in no case showed the concave-upward sides of the peak of the "friction hill" expected from the v. Karman or Orowan theory; the pressure curves were always humped (concave downward). Only Nadai obtained theoretical curves of that form, and his assumptions as to friction are inadmissible. And the two-humped curves found experimentally in 1951 in the ASME-sponsored work at Massachusetts Institute of Technology (but only recently published) are beyond the possibility of explanation by the present mathematical theories. All of this indicates that what is now required is much more experimental work rather than further mathematical refinement.

The paper by Mr. Jortner stands out above most other recent work, in that it is not merely (though partly) a refinement on a refinement of earlier pioneer work. Referring to such other work, refinements have their place in pure science, but from the engineering standpoint it is exasperating to see so much patient effort and even ingenuity expended on something that makes a difference of probably not over 2 or 3 per cent, while other much more important problems have never been tackled.

The reason for this situation probably is that students choosing subjects for papers either do not know the problems, or cannot evaluate their relative importance. On the other hand, it may be due to groove-mindedness or lack of originality.

Donald Jortner: In answer to Mr. Phillips; it is hoped that a large part of the inaccuracy connected with predictions made for thin strip is eliminated by the method of approach described in this paper. The major effort is concentrated on improving the mathematical description of roll flattening and the elastic regions in the strip. It is thought that these effects are responsible for the analytical difficulty encountered with thin strip. The quantitative accuracy of this method has not been determined for strip less than 0.018 in. exit thickness. However, the results in Table III are encouraging.

Only deformations in the strip and the work roll were investigated. No attempt was made to analyze the mill housing or backup roll deformations.

In answer to Mr. Keller, it is not expected that taking full account of the roll curvature has a serious effect on the calculated contact length. However, it *is* expected that the use of the actual pressure distribution for the determination of roll surface shape can cause a large change in the calculated contact length. In previous methods, a semi-elliptical pressure distribution is inherently assumed. From the shape of the pressure distribution and from energy considerations, it may be concluded that the semi-elliptical pressure assumption overestimates the length of contact. A more complete description of this effect appears in the thesis.

For the cases investigated (results in Table III), it was found that the elastic regions in the strip comprise about 5 to 15 per cent of the contact length. Of course, this percentage becomes larger as the plastic reduction becomes smaller until, at zero reduction, the entire contact length is elastic.

With reference to the minimum strip thickness obtainable, the quantity mentioned in this paper is the screwdown pressure which exists for a pass of zero reduction at a given strip thickness. This does not really correspond to the situation Mr. Keller discusses but only to the limiting point at which the exit thickness equals the entry thickness. Continued work on the mechanics of rolling and wire drawing is in progress at Carnegie Institute of Technology. In addition, a technical paper is in progress which will include among other things the mathematical expressions which Mr. Keller requests for use in fatigue analysis of rolls.

Regarding the value of further theoretical analysis in this problem, it is our belief that a mass of experimental data uncorrelated by theoretical analysis is of little use in uncovering basic scientific truths. A mathematical refinement may have a considerable amount of value in determining the physical cause of measured results. This can be true even when the refinement apparently has no immediate engineering application as is often the case. ▲

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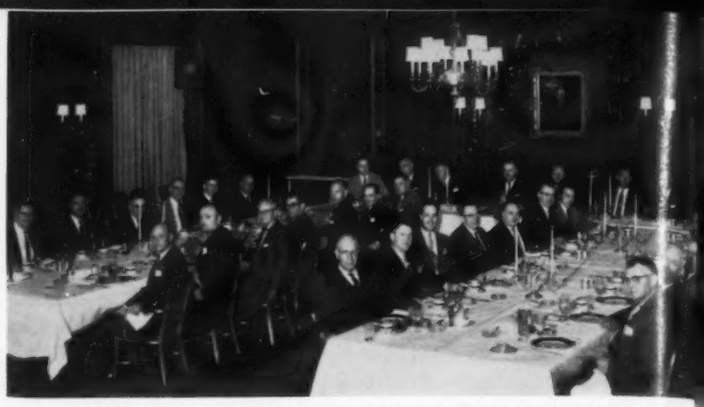

The AISE Board of Directors, District Secretaries and Headquarters Staff gather for dinner prior to the opening of the Spring Meeting.

Pictorial Roundup

AISE Spring Meeting

The Statler Hilton Hotel
Buffalo, N.Y.
April 27, 28, 29

Registration (1) for the meeting was 792.

Authors and chairmen met at breakfast each morning to outline plans for the various sessions. Shown are members of the mechanical session (2); one of the rolling mill sessions (3); and electrical session (4).

Louis Moses (5) presented paper on "Mathematical Aids to Determine Bar Spread and Reduction Rates in Rolling."

"High Head Alloy Slab Heating for Planetary Mill Rolling" was the title of a paper presented by Oscar J. Zanatta (6).

R. P. Schuler, rear in (7), opens off-the-record panel discussion in flat products session, and in (8) members of the shaped products session ponder a question from the floor.

Typical of the interest in the various sessions is the group shown in (9).

INSTEP participants who attended the meeting were Vinod Garg, Raj Jain, V. Y. Phatak and M. K. Lahiri (10).

AISE President Emil Kern and guest speaker H. George DeYoung, president of Atlas Steels Ltd., huddle in (11).

A reception for speakers table guests preceded the informal stag banquet. In (12) C. J. Murray, Buffalo plant manager, Wickwire Spencer Steel Division, Colorado Fuel & Iron Corp., W. A. Thomas, vice president—operations, Atlas Steels Ltd.; M. A. Leishman, works manager, Steel Co. of Canada; C. W. Bruce, chief engineer, Republic Steel Corp., and C. Clarke Wales, chief project engineer, National Tube Division, U. S. Steel Corp., renew acquaintances.

Climax of the meeting was the inspection trip (13) to Atlas Steels, Ltd., Welland, Ontario, and the direct reduction plant of Strategic-Udy Metallurgical & Chemical Processes, Ltd., Niagara Falls, Ontario, Canada. More than 300 made the trip and also enjoyed a lunch between the two tours at the Sheraton Brock Hotel, overlooking Niagara Falls.

Shown in (14) are a portion of the 400 men who attended the informal stag dinner.

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View of downtown Salt Lake City with the Wasatch Mountains in the background

PROGRAM

AISE Western Meeting

HOTEL UTAH,
SALT LAKE CITY, UTAH

June 15, 16, 17, 1959

MONDAY, JUNE 15, 1959

8:30 am—REGISTRATION—
Mezzanine Floor

9:00 am—TECHNICAL SESSION—
Lafayette Ballroom

Chairmen: R. L. Dowell, Assistant to General Superintendent, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

Walter Lee Murphy, Assistant General Manager, Bethlehem Pacific Coast Steel Corp., South San Francisco, Calif.

"Modern Electrolytic Tinning Line Electrical Drive Systems," by J. E. Kraske, Steel Mill Application Engineer, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Maintenance of Mill Oil Bearings," by C. A. Bailey, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa., and A. C. Cooper, Superintendent of Roll and Tool Shops, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio

"Modern Regenerative Soaking Pits," by Henry S. Hall, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

2:00 pm—TECHNICAL SESSION—
Lafayette Ballroom

Chairmen: W. H. Kinney, Assistant to Vice President of Operations, Kaiser Steel Corp., Oakland, Calif.

W. Truxton Purvance, Project Analysis Engineer, United States Steel Corp., Pittsburgh, Pa.

"Improved Hearth Life of the Blast Furnaces at Colorado Fuel and Iron Corp.," by John W. Carlson, Superintendent, Blast Furnace Dept., The Colorado Fuel and Iron Corp., Pueblo, Colo.

"The History and Performance of the HyL Sponge Iron Process," by Ing. Juan Celada, Chief Engineer, Hojalata y Lamina, S.A., Monterrey, Mexico, C. K. Mader, Project Manager, and R. Lawrence, Jr., Sales Manager, Metallurgical & Process Industries, The M. W. Kellogg Co., New York, N. Y.

"Trouble Spots in Sintering Plants," by Gordon R. Baer, Manager, American Ore Reclamation Section, Freyn Dept., Engineering and Construction Div., Koppers Co., Inc., Pittsburgh, Pa.

5:30 pm—BARBECUE

Buses will leave Hotel Utah at 5:30 pm for special canyon barbecue.

R. L. DOWELL

W. L. MURPHY

W. H. KINNEY

W. T. PURVANCE

TUESDAY, JUNE 16, 1959

9:00 am—TECHNICAL SESSION— Lafayette Ballroom

Chairmen: William Brill, Director of Engineering, The Colorado Fuel and Iron Corp., Pueblo, Colo.

W. E. Harris, Assistant Plant Superintendent, Consolidated Western Steel Div., United States Steel Corp., Los Angeles, Calif.

"Cost Estimating—Metal Working Plants," by A. J. Mosso, Executive Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

"Reclamation of Waste Waters at Geneva Works," by Earl H. Peirce, Combustion Engineer, and Ralph D. Hancock, Assistant Power & Fuel Engineer, Power & Fuel Engineering, Engineering Div., Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

"Modernization of the Seattle Plant," by N. L. Bock, Chief Engineer, and Kenneth Grant, Electric Furnace Superintendent, Seattle Plant, Bethlehem Pacific Coast Steel Corp., Seattle, Wash.

2:00 pm—TECHNICAL SESSION— Lafayette Ballroom

Chairmen: Frank F. Argust, Superintendent, Industrial Engineering, The Colorado Fuel and Iron Corp., Pueblo, Colo.

T. G. Simison, Assistant General Superintendent, Rolling Mills, Kaiser Steel Corp., Fontana, Calif.

"Automatic Hot Strip Thickness Control—Geneva Works," by Louis E. Ringger, Assistant Works Engineer, and George S. Koss, Assistant Division Superintendent, Rolling Mills, Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

"Hot Strip Finishing Mill with Automatic Gage Control—Process System Analysis and Design," by Hugh S. Maxwell, Application Engineer, Metal Rolling & Processing Engineering, and R. A. Phillips, Application Engineer, Industrial Analytical Engineering Unit, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

"Quality Control at Pittsburg Works Particularly Related to Flat Rolled Products," by G. A. Jedenoff, General Superintendent, Pittsburg Works, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

7:00 pm—INFORMAL STAG DINNER— Lafayette Ballroom

Welcome by the Honorable George D. Clyde, Governor, State of Utah

Speaker: L. B. Worthington, President, Columbia-Geneva Steel Div., United States Steel Corp., San Francisco, Calif.

WEDNESDAY, JUNE 17, 1959

8:30 am—INSPECTION TRIP—

Inspection Trip to Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah. Buses will leave from Hotel Utah.

hotel reservations

Because of a Latter Day Saints church conference, which ends Sunday, June 14, arrivals in Salt Lake City should not be timed before that day.

Write direct for hotel reservations to Hotel Utah, Salt Lake City, Utah, giving time of arrival and type of accommodations desired. Reservations should state that they are for the AISE Western Meeting.

transportation

Individuals or groups desiring assistance in planning their trip should get in touch with the office of American Express Co. in their respective cities, or with any local travel agency.

WILLIAM BRILL

W. E. HARRIS

F. F. ARGUST

T. G. SIMISON

Abstracts of Technical Papers

to be presented at

AISE WESTERN MEETING

June 15, 16, 17, 1959

HOTEL UTAH,

SALT LAKE CITY, UTAH

"MODERN ELECTROLYTIC TINNING LINE ELECTRICAL DRIVE SYSTEMS"

by J. E. KRASKE, Steel Mill Application Engineer, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

J. E. KRASKE

△ COMPETITION and demand for high quality electrolytic tinplate has necessitated the high-speed electrolytic tinning line equipped with modern electrical drives and control systems. The mechanical arrangement and the method of processing the strip varies with each type of tinning line. Therefore, the electrical drives and control systems must be tailored to meet the requirements of each line.

The basic control schemes that are used to accomplish this are (*a*) the common bus scheme, (*b*) the individual generator scheme, and (*c*) a combination of both (*a*) and (*b*). The common bus scheme consists of a generator for each of the two or three sections (depending on the mechanical design) of the line, with the sections tied together by regulators or other means so that they accelerate and decelerate together. The individual or multiple generator scheme utilizes a separate generator to supply each individual drive, such as pay-off reels, with each generator tied together as in the case of the common bus system. The combination system is what the name implies and has become increasingly important as "the" control system. With this system the salient features of both the common bus and individual generator scheme can be incorporated to the best advantage. Each of the three schemes can be designed to meet the individual line requirements with the individual generator scheme providing the ultimate in flexibility followed by the combination system and the common bus system.

The control for the equipment necessary to produce the product for which the line was designed, although not considered as line drive control, must be accurately co-ordinated with it to produce the ultimate product efficiently and economically as possible. This associated equipment includes: cleaning, pickling, plating, and chemical treatment low voltage power supplies; reflow equipment; and a-c motors and control. The low voltage power supplies can be divided into two categories each with its own type of control, first the rotating equipment and second the rectifiers or static supplies.

Unlike the low voltage power supplies there are several categories into which the reflow equipment can be divided each with its own type of control. The most important of these categories are the conduction or resistance type heating, the induction or r-f reflow, and the combination of the two. The control for the first two are entirely different but are combined in the combination reflow system so that both systems are controlled by the induction reflow flow line scanner. The a-c motors and control even though there are many combinations for each line are for the most part standard pieces of equipment utilizing standard a-c control that is interlocked with the adjustable voltage control.

There are four relatively recent developments in equipment and control. First, silicon diode rectifiers are used for both low voltage power supplies and line drive supply. These diodes have largely replaced the germanium diodes for the low voltage application. Secondly, the combination induction and conduction

heating for reflow provides a finer control of reflow and alloy layer than was possible with the conduction heating alone. Third is the advent of data accumulation or logging systems occasioned by a changing tinplate market. The last one is the development of the new line of d-c machines with faster response characteristics.

"MAINTENANCE OF MILL OIL BEARINGS"

by C. A. BAILEY, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa., and A. C. COOPER, Superintendent of Roll and Tool Shops, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio.

C. A. BAILEY

△ MAINTENANCE procedures for the two normally used oil bearings are presented. The procedures have been selected in part from industry practices and in part from manufacturers' recommendations; they are presented to obtain optimum bearing maintenance by establishing guides.

Shop conditions and maintenance procedures that are conducive to the attainment of optimum bearing life are offered. Recommendations for roll and bearing shop practices are made; ideal locations and conditions of these shops are noted. Solutions to common occurrences involving the maintenance and installation of the mill oil bearings are considered, as are the instruments and methods of checking various parts.

A. C. COOPER

The selection and care of a lubricant for mill oil bearings are reviewed. A bearing manufacturer's lubricant requirements are noted, as are a consumer's benchmarks. Various laboratory tests are illustrated. These tests may be employed for the selection and evaluation of a new or used lubricant.

"MODERN REGENERATIVE SOAKING PITS"

by HENRY S. HALL, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

H. S. HALL

△ DURING the last four or five years the regenerative soaking pit has been modernized quite extensively and instrumentation has been applied to it so that it is now a fully automatic heating furnace.

Soaking pits have been built recently to burn the entire range of fuels from straight blast furnace gas through mixed blast furnace and coke oven gas on up to straight natural gas and Bunker C oil.

The paper covers designs and installation of over 100 holes of modern regenerative soaking pits over the past four or five years.

"IMPROVED HEARTH LIFE OF THE BLAST FURNACES AT COLORADO FUEL AND IRON CORP."

by JOHN W. CARLSON, Superintendent, Blast Furnace Dept., The Colorado Fuel and Iron Corp., Pueblo, Colo.

J. W. CARLSON

△ THE life of blast furnace linings at the Pueblo Plant of C. F. & I. are reviewed from 1940 up to the present. A series of low tonnage hearth failures, during the 1940's, caused the corporation to turn to carbon for a hearth lining on "E" Furnace in 1946. A much improved life on that lining resulted in four furnaces eventually using carbon hearths. Other items contributing to longer stack life were throat armor and high duty brick in the throat section and at the mantle of the furnace.

A daily report, kept by the furnace foreman, showing tap hole data on each cast, and the use of carbonaceous tap hole mix to eliminate water at the tap hole, led to a very good tap hole practice.

The first part of the paper covers the lining life of the furnaces in general, with particular attention given to the first and second linings on "E", that used the carbon hearths. Photographs and sketches show the hearths after the campaigns.

The second part of the paper covers the tap hole practice, giving comparisons of the water mixed clays and the tar carbonaceous material. Included in this is a description of the present preparation and use of carbonaceous tap hole material. Photographs are given of the present method of drilling the tap hole for casting.

"TROUBLE SPOTS IN SINTERING PLANTS"

by GORDON R. BAER, Manager, American Ore Reclamation Section, Freyn Dept., Engineering and Construction Div., Koppers Co. Inc., Pittsburgh, Pa.

G. R. BAER

△ ALTHOUGH the first ferrous sintering plant was placed in service in the United States in October, 1911, it is only of recent years that the sintering process has been applied to its great potential of:

1. Preparation of unsuitable iron-bearing materials for use in the blast furnace.
2. Increasing blast furnace production from existing units.
3. Production of pig iron with less consumption of fuel.

This change has necessitated a complete appraisal of the sintering process including materials and equipment. New techniques in the handling, preparing, control and proportioning of raw materials with maximum production, control and handling of product with minimum degradation, are now in operation.

The American Iron and Steel Institute founded an "Agglomeration Fellowship" at Mellon Institute July 1, 1949, with the objective of developing improved

blast furnace sintering and agglomeration. Many useful and enlightening papers were published covering the work of these men through a 2-year period.

The summary of these reports enumerate many ways in which sinter could be improved. Great strides have been directed toward this accomplishment over the past five years with the result of improved sinter and better blast furnace practice. However, these improvements have not all been accomplished without some trouble spots. A review of those new innovations and practices are enumerated in this paper.

Some of the predominant trouble spots dealt within this paper (and measures for their correction) are as follows:

1. Dust collecting discharge valves
2. Mixers
3. Controls
4. Feeders
5. Sinter machine
   a. Supports
   b. Deflection
   c. Drive
   d. Expansion and adjustment
   e. Automatic stop
6. Sinter cooler
7. Hoppers
8. Chutes and junction Points
9. Conveyors
10. Scalpers, screens and grizzlies

This business of sintering is a constantly advancing art so that each new plant that is built is "more nobler than the last." Accordingly those industries that purchase a sintering plant built from designs "off the shelf" must be content to accept an outdated model.

"THE HISTORY AND PERFORMANCE OF THE HYL SPONGE IRON PROCESS"

by ING. JUAN CELADA, Chief Engineer, Hojalata y Lamina S.A., Monterrey, Mexico, C. K. MADER, Project Manager, and R. LAWRENCE, JR., Sales Manager, Metallurgical and Process Industries, The M. W. Kellogg Co., New York, N. Y.

ING. JUAN CELADA

C. K. MADER

△ THE iron and steel fraternity have become increasingly interested in direct iron ore reduction processes. This has been particularly true of cold-metal operators relying entirely upon scrap as a source of metallic units for their electric furnaces.

The successful operation at Monterrey, Mexico, of a 200-ton per day direct reduction plant using reformed natural gas as the reducing medium has been of great interest to the metallurgical industry.

The process was developed by the Mexican steelmaking firm, Hojalata y Lamina S. A. (HyL). The present plant has been in commercial operation since November 17, 1957, and was designed from pilot plant data obtained at Monterrey. The plant

R. LAWRENCE, JR.

produces 200 tons per day of sponge iron which is charged directly into a conventional electric finishing furnace for the production of steel ingots.

The paper covers the developmental history of the process from the original tunnel kiln sponge iron plant through the gaseous pilot plant phase to the present 200-ton unit. On-stream efficiency figures for the first 15 months of operation are given and some of the operating difficulties defined. The paper also includes a description of the basic operating cycle and electric furnace melting technique employed by HyL at Monterrey, Mexico.

A ten-minute sound picture of the plant in operation will be shown as part of the presentation.

"COST ESTIMATING—METAL WORKING PLANTS"

by A. J. MOSSO, Executive Vice President, Auburn & Associates, Inc., Pittsburgh, Pa.

A. J. MOSSO

△ PERHAPS the most perplexing problem a mill engineer will ever be called upon to solve during an entire career is his first attempt to estimate the costs of a major plant expansion before any engineering is completed. This would include estimates made for appropriation purposes and, if done in sufficient detail, could be used as a basis for a cost control scheme. Emphasis is placed on the construction or installation of the program since it is here that the mill engineer encounters the most difficulty.

It is not the intention of this paper to cover the detailed and accurate but time consuming methods used by contractors in arriving at prices for bid purposes after the construction engineering is reasonably complete. The paper is intended to be of assistance to the mill engineer who must make cost estimates long before the equipment is purchased and before the engineering has progressed beyond general arrangements of equipment.

The author begins with a discussion of the information that must be assembled for the estimate and points out the main sources of information and help which can easily be obtained.

This is followed by assuming a fictitious project and outlining the components of the job with the quantities and unit prices used to arrive at a total cost for each major phase of the job. All factors of an estimate from site preparation to the contingencies are covered in the discussion.

The estimate is followed by a brief discussion of the accuracy which can be obtained by the method outlined. Sign posts and guides are given which prevent an estimator from making major errors of omission or commission.

The paper also touches briefly on the relationship

between the cost estimate and the construction engineering. The importance of proper direction of the project and its effect on an early estimate is brought to light. The author also touches briefly on the more important economies which can be incorporated into a project to keep costs in line without reducing the quality of the program.

"MODERNIZATION OF THE SEATTLE PLANT"

by N. L. BOCK, Chief Engineer, and KENNETH GRANT, Electric Furnace Superintendent, Seattle Plant, Bethlehem Pacific Coast Steel Corp., Seattle, Wash.

N. L. BOCK

KENNETH GRANT

△ AN evaluation of the future steel requirements in the northwest indicated increasing demands for quality as well as quantity so Bethlehem Pacific has completed a modernization program for their Seattle plant which included (1) replacing the open hearth shop containing five furnaces with an entirely new electric furnace melt shop with two furnaces, new buildings, etc.; (2) installing a new 32-in. 2-high blooming mill with eight holes of soaking pits, auxiliary mill tables, shears, new buildings, etc., ahead of their 4-stand, 22-in. mill; and (3) replacing the antiquated 7-stand, 16–12-in. mill in its entirety (but within the same building) with a modern 14-stand automatically controlled merchant bar mill and a 240-ft cooling bed. Additionally, a direct reading spectrograph, a telautograph, and a pneumatic tube system were included.

The electric furnaces provide high production of quality product at higher yield than open hearth furnaces and require less space per unit of production; the blooming mill permitted the use of large ingots while the merchant bar mill is an efficient, high production unit.

With the completion of this program the Seattle plant can produce more steel more economically, and with improved quality control.

"HOT STRIP FINISHING MILL WITH AUTOMATIC GAGE CONTROL—PROCESS SYSTEM ANALYSIS AND DESIGN"

by HUGH S. MAXWELL, Application Engineer, Metal Rolling & Processing Engineering, and R. A. PHILLIPS, Application Engineer, Industrial Analytical Engineering Unit, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

H. S. MAXWELL

△ DURING the last several years, extensive analytical work has been done in the field of control of strip thickness in hot strip finishing mills. This paper presents the mathematics involved when hot strip is reduced in the tandem finishing mill. The methods of analysis are described. The relationships between the mathematics of plastic flow and electrical control systems, and system design based upon the mathematical relationships are presented and explained.

R. A. PHILLIPS

This is original work and is a significant contribution to the field of rolling process—system design. The paper itself includes the equations for the benefit of those actively interested in the mathematical relationships but the oral presentation will concentrate on methods of approach, methods of gage control and significance.

"QUALITY CONTROL AT PITTSBURGH WORKS PARTICULARLY RELATED TO FLAT ROLLED PRODUCTS"

by G. A. JEDENOFF, General Superintendent, Pittsburg Works, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

G. A. JEDENOFF

△ THE paper outlines the broad responsibilities for quality control of sales, engineering, operating, maintenance, and metallurgical departments, giving United States Steel Corp's objective, and pointing out how quality control is essential to this business philosophy.

The general nature of the facilities installed at Pittsburg Works for the production of sheets and tinplate are described. A series of seven slides is used to illustrate the principal units.

Operation of the facilities previously described requires development of standard operating and maintenance practices, and establishment of production and quality objectives; however, successful performance depends not only on tools and procedures, but on how well they are managed and operated by *people*.

Also the degree of success achieved in quality control, as in most phases of business, depends on the effectiveness of people. The paper describes the principles of management development used at Pittsburg Works as an integral part of the quality control program.

Seven examples cover the kind of approach to people that has proved effective in promoting employee quality-consciousness. A series of nine slides with appropriate narrative remarks is used to describe these activities which include (1) job quality guides, (2) quality reminder signs, (3) single objective quality meetings, (4) daily quality round table, (5) customer product displays, (6) employee suggestion plan, and (7) plant visitation program.

Summarizing the approach to quality control used at Pittsburg Works is as follows:

1. Use an individual approach—to make *each* employee conscious of his *own* influence in quality.

2. Stress through better communications *why* quality control is vital to the customer, the company, and to each employee.

3. Stimulate interest—use pictures, samples, and personal experience to make the quality control program as *current* and *dynamic* as possible.

4. Place responsibility for quality performance on each operating employee concerned.

by John C. Cramer, Vice President
Albert Ramond and Associates, Inc.,
Chicago, Ill.

Incentive Trends

THE year, 1958, may be described as one of economic stress, and as such, it placed added emphasis on the need for lower costs and improved product quality.

Since these two objectives are fundamental to the basic concepts of a sound wage incentive program, it is indeed appropriate that past history be examined, the current situation reviewed, and forecasts made on the future trends that are likely to occur.

Organized labor in the steel industry has stated:

> "The greatest objective of the United Steelworkers of America, since its inception, has been to obtain equal pay for similar work for employees under its jurisdiction."

In broad terms this is a commendable statement. It clearly states the objective. However, the means of reaching it is not spelled out, and therefore, one can only speculate by using past history and evaluating trends.

WAGE EQUITY

"Equal pay for similar work"—the job classification program, now completed for several years, has produced equitable standard hourly wage rates for the various occupations. Aside from the changes in job requirements that will occur as new situations are encountered, equal rates of pay for equal rates of skill, responsibility, effort and working conditions are now an accomplished fact.

The job classification program has been extended to another important segment of the steel industry; namely, the raw material properties. However, in the ore mines there were some changes made in the manual. It was found that the factor weightings had to be changed in order to reflect the actual conditions. By so doing, there was a definite change in attitude on what the basic program would do. In the past the factor weightings were regarded as inviolate, and they would fit any situation.

So here is a trend in the field of wages that is a healthy one. Another important segment of the industry, the steel fabricators, is now undertaking a job classification program. It is to be hoped that the parties involved display the same appreciation toward their problems as was done in the ore mining. In other words, the past and current history demonstrates that there is no single plant to fit all situations when it comes to establishing base wage equity, an important point to remember.

INCENTIVE BASE

With the establishment of standard hourly wage rates, the first step toward solving the problem of incentives was accomplished. For example: wage negotiations over the years had been confined to hourly rates and "across the board" increases. In principle, these practices did not disturb the then existing incentive plan, particularly when it was a loose one. However, as time went on, the difference between the new standard hourly rate and the old incentive base rate became greater so that the incentive plan either was cancelled or its strength became so weakened that it was no longer meaningful.

Under these conditions, the employees were quick to see that: (1) the traditional difference in wages in comparison with other occupations was getting smaller, and (2) they were denied recognition for their contributions toward lowered costs.

It is at this point that there was a change in the incentive trend in the industry. The employees' desire to have incentives, to have as many of them participate as possible, was summarized by their demand that all new incentives use the new standard hourly wage rate as the basis for calculating incentive wages. Call this a trend if you will, but if it is, it is confined to steel. For many years other industries have employed incentives in which the standard hourly rate and the incentive base rate have been identical.

Briefly, here is steel's situation. The strength gained by the employees in the job classification program, the firm stand now taken with respect to the incentive base, and the more recent demand that 80 per cent or more of the employees must have the opportunity to participate in incentive earnings, represents a trend toward more and more recognition on their part with respect to the conduct of steel's business.

EQUAL PAY

With what has been done so far, steel is probably now entering an era where there will be greater strains on the entire collective bargaining process. It can become more difficult, more complex, and more costly.

To satisfactorily operate, there must be a proper balance between cost and wage performance results. Also, it seems quite fair and reasonable to expect that management should have the exclusive right to so

In The Steel Industry

manage its business that it will obtain maximum efficiency from the company's operations. To realize this, the company should have the exclusive right to:

1. Determine the extent of incentive coverage.
2. Determine the type of incentive plan to be used.
3. Establish the incentive principles and administrative policies.
4. Establish the incentive earnings potential.
5. Determine the procedure for re-establishing incentive earnings equity.

Attempts have already been made, and are now being made, to restrict the scope of these rights. Perhaps a few actual case histories in steel will serve to illustrate the trends.

. . . . wage incentives, like many important management functions, involve decisions that should be made by a company in terms of its own cost objectives, production facilities, and competitive situation and with the object of attaining these cost objectives without destroying its labor relations . . . .

INCENTIVE COVERAGE

"We are of the opinion that no one system can cover all of the operations in the steel industry—." Incidentally, that is our opinion too—the foregoing is a quote from a steelworker official.

A guiding principle in the achievement of high incentive coverage is to design the standards and resulting wage incentive plan so that they will reflect the actual operating characteristics of the job. For example: a plan designed for highly repetitive, well standardized man or equipment operations cannot be used for jobs that are subject to many variables.

The major reasons for the limited use of the single plan idea are: (1) it is not flexible enough to recognize variables and (2) if variables are recognized, the inevitable result is a series of wage incentive inequities.

There is, of course, an infinite field of choice with regard to incentive plans. The final selections involve decisions that have to be made by the individual company, in terms of its own cost objectives, production facilities, and competitive situation.

Several years ago a company using the single plan idea was requested by the union to increase the incentive coverage. An analysis of their problem showed that 39 per cent of the employees were on incentive. Further study revealed that through full use of the single plan idea incentive coverage would go to only 44 per cent.

Since this was considerably short of the union goal of 80 per cent or better, it became quite obvious that the single plan principle would have to be abandoned. Further examination of the operations revealed that seven incentive plans, designed so that each would reflect the complexities of the work, would help solve the problem. Each of the seven plans was so conceived that they would yield the full earnings potential when

full opportunity existed. This is an important point if incentive earnings equity is to be maintained.

A review of the problem further revealed that 11 per cent of employees would be excluded from incentive participation. This was due to type of occupation, difficulty in recording production, unstandardized methods, and so forth.

Thus, in summary, incentive participation could be raised from 39 to 89 per cent by the adoption of a practical and realistic policy with regard to the type of incentive plan to be used.

Should there be a trend toward a single type of plan, forget it, unless a limited incentive coverage is wanted.

INCENTIVE PLANS

In this area, the trend at the international union level seems to be to get away from work measurement plans and to point toward equipment utilization plans. If the incentive concept is to be fair and equitable it must be one that gives proper balance between these two extremes.

In its simplest terms the basis for incentive should be closely geared to a modest range of objectives or goals such as:

1. Utilization of equipment.
2. Work load of the individual or crew.
3. Quality of product.
4. Control of associated expense—scrap, fuel, power.

INCENTIVE EQUITY

The relationship with others on incentive should be balanced and equitable. The worker who has put out for the full hour wants incentive pay recognition beyond the worker who has less work available. He also wants the plan well administered and maintained so this remains in effect.

Incentive equity also requires that on full opportunity jobs where performance is fully controlled by the crew's own effort, the incentive earnings potential will be the full amount. Where less than full opportunity for work exists, because performance is restricted by equipment or operating limitations, the incentive earnings opportunity will be proportionately less.

For a number of years a popular concept was the exact opposite to this one. It was the idea of equal incentive opportunity regardless of work load. Presently, the trend is away from this and pointed toward incentive opportunity in proportion to work load.

Some of the reasons for this change may be traced to arbitration awards in which the arbitrator has supported the idea that incentive pay should be in proportion to work. Another source is that the workers themselves usually judge the equity of their pay in terms of how hard they work. Still another is that when equipment and layouts are changed so that performance is improved, there is a better atmosphere when the worker is provided with added incentive opportunity.

With this trend in the judgment of what constitutes incentive equity, the signs now point toward work measurement as the basis for an incentive plan. Next, to a limited degree, will be equipment utilization where return on capital investment is the major consideration.

INCENTIVE OPPORTUNITY

Incentive opportunity or incentive potential refers to the amount of money that a qualified worker exerting his best effort will earn on a full opportunity or unrestricted job. It is not a ceiling, nor is it an average.

At the present time this potential is established at 35 per cent above the standard hourly rate. Most authorities agree, and arbitrators have supported, this level is one that provides equitable incentive compensation.

Currently through discussions and negotiations on other matters, there appears to be some little pressure to raise this figure to somewhere near 150 per cent. This is a trend that must be watched closely because of the cost implications.

Presently, steel is working under a high base rate philosophy. Accordingly, it does not appear necessary to raise the incentive potential to 150 per cent to obtain maximum production. Furthermore, it is doubtful if such a change would provide answers to the many industrial relations problems associated with incentives.

The picture becomes darker when viewed from the cost angle. If the earnings potential was changed from 135 to 150 per cent without a corresponding improvement in productivity, wage and cost levels would be increased about $0.40 per hr. The impact of this would probably prohibit capital expenditures for cost recovery.

In conclusion, a word of caution is in order for any discussions or negotiations regarding: (1) incentive potentials or wage adjustments that may be made to bring earnings in line or (2) to recognize earnings differentials that crop up when changes are made.

WAGE STRUCTURE

Since 1951 the average job class in steel has been slowly rising. Much of this has been caused by negotiating wage increment increases. In the skilled trades the effect of this has been even more pronounced. The net effect is that to maintain wage equity and obtain some cost recovery, incentives for skilled maintenance workers are now in demand. This trend should be actively supported.

It is logical to expect improvements in equipment and methods. Experience shows that this will also tend to bring about a higher average job class and greater participation by the skilled trades in the cost results. Thus, there will be added pressures for incentives, and the demand for 80 per cent or more participation by the employees will be further supported.

EARNINGS DIFFERENTIALS

This refers to the payments made for the differences in earnings when an old incentive plan is replaced by a new one. The procedures used in this area are practically static. However, with the pressure for changes in incentive concepts, increased incentive participation, and the challenging decisions faced by the union and the companies regarding the future course of incentives, the future should bring about increased activity in this field.

It has been granted that the workers have an equity in the difference between the old and the new plan.

However, the present procedures scarcely fulfill the stated objective of equal pay for similar work.

In the job classification program techniques have been worked out for the elimination of red circle rates. It appears reasonable that a similar program could be used for earnings differentials. We must have a trend in this direction to achieve equity in the wage structure.

Drawing on experience elsewhere, the textile and electronic industry have recognized the employees' equity in the old plan by a lump sum payment. In some cases the payment has been immediate. In others it has been paid over a period of time and in proportion to the amount involved. This latter procedure is the more desirable as the impact of the change is lessened and all concerned are given more time to make adjustments to the new conditions.

SUMMARY

At this point a few pertinent comments are in order on the topics covered.

1. Equal pay for similar work will no doubt be the policy that will govern incentive trends.
2. A major portion of this policy has been realized through the job classification program. Do not overlook the trend toward adjusting the manual to fit actual conditions.
3. The trend toward using the standard hourly wage rate as an incentive base has already started. It will continue to grow.
4. Examine incentive policies. The demand for increased incentive participation will be a major point in future bargaining.
5. There is a trend to participate more actively in management policy by using incentives as an avenue of approach.
6. If a single plan is now used or its use is contemplated, only limited coverage will be had, and further wage inequities will be created.
7. Incentives designed to fit specific situations yield better results on the long-term basis.
8. Promote the incentive concept based on the extent of workers' contribution—work load.
9. An incentive opportunity of 35 per cent is adequate to encourage maximum production and to pay equitable incentive compensation.
10. Find a better way to handle earnings differentials. There should be more activity on this problem because its solution is essential if equity in wages and incentives are to be had.

We have no illusions regarding the problems, trends, and difficulties that exist in the incentive area. With better understanding, the acceptance of sound and equitable policies, and the support of strong organization leadership, these trends can be channeled so all can benefit.

Discussion

PRESENTED BY

DUANE ADAMS, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

JOHN C. CRAMER, Vice President, Albert Ramond and Associates, Inc., Chicago, Ill.

R. B. HEWETT, Company Industrial Engineer, Crucible Steel Co. of America, Pittsburgh, Pa.

Duane Adams: Assuming that the job classification program has set equitable base wages, what basis can be used for incentives for maintenance personnel not assigned exclusively to a specific production unit? If there is such a plan now in use, just what tangible gains have been realized in return for the additional incentive pay? Since most maintenance work is strictly nonstandardized, what is the trend in approach to this problem?

John C. Cramer: Generally speaking, on incentives for maintenance workers, particularly in the shop area, the standards on which the incentives are based are derived from basic data established by time study. The field studies are also based on time study, much of which can be drawn from the shop's experience, and some of which is established directly as the jobs develop.

There is one field of incentives in which it is impractical to use the direct measurement technique. In that particular area, the basis for standards is developed from activity studies, which you may call a work sampling procedure. The results are then related to the proper determinants and used for the basis of payment.

Now, there is one thing that I think is rather important in connection with your question which was: How much does it cost, and what do you get out of it? I assume you are referring to administrative costs; and in connection with costs, which is an extremely important thing, there are a number of very pertinent decisions to be made by management. As I outlined in this paper, your choice of an incentive program will be governed by your facilities, what your objectives are, and your competitive situation.

I believe that in our some 35 years of experience we have met practically every situation, although from time to time we meet some new ones. Some companies would like to have, for example, a precise machine shop setup in which all standards are derived from a basic standards manual, the employees working in the shop on an individual basis, their incentive calculated and paid on a shift basis. Incidentally, that represents a rather high administrative cost.

We have other cases where the atmosphere existing at the particular plant, not only among the plant mangement but also in the union, is a group situation. That, of course, means that standards can be "gobbed" a little bit more. The application becomes considerably more simple and the cost is very, very low. There are other fields in the maintenance program where the administrative cost is also very small because records are such that you can accurately measure past history.

So, as far as administrative cost is concerned, let me put it this way: It ranges from a very low cost, something less than one per cent, to one that I regard as rather high, namely, about five per cent. There are a number of factors that govern it. Are you going to have individual or group? Are you going to calculate incentive on a daily basis, a weekly basis, a monthly basis, or on a pay period? Are the type of standards you use going

to be precise time study work measurement standards, or are they going to be derived from past records? All those things have an effect on administrative costs.

Now, with respect to the gains, the increase in productivity as a result of putting in incentives on maintenance occupations will range all the way from zero up to 30 or 40 per cent. The increase is dependent upon a number of factors. First, where were they before the incentive plan was put in? Secondly, what kind of leadership has been provided to them to enable them to do better? I feel that insofar as a general figure is concerned, it is quite safe to say there would be a 25 per cent improvement.

We have found that in dealing with the very tops in measurement, the very tops in control, with respect to maintenance cost—and with a good reception by the company and by the union with respect to the equity and the objectives of the incentive plan—you have a difficult time getting anywhere unless you plan and schedule your maintenance, and very often that is a very definite deterrent, if not the complete road block, with respect to improvement.

There are many factors, but administrative costs should be something less than 5 per cent and your improvement should be something more than 25 per cent. The resultant wage increase will, again, depend on where they were before; but, generally speaking, it runs in the neighborhood of 15 to 20 per cent.

R. B. Hewett: Good management requires that modern effective equipment be furnished and the best operating practices established. Good management must also provide the worker with the will and the desire to perform his individual or teamwork task to operate equipment at full capacity with the fewest delays to produce the best quality product at lowest cost.

The generally accepted means of obtaining this will to produce in the steel industry has been through the use of wage incentives. Increased incentive coverage over the years, has increased management's problems and difficulties in this area. However, none of these problems are insurmountable, and the advantages of good incentives certainly outweigh the disadvantages.

Mr. Cramer has presented ten distinct trends in the incentive field, and I must agree that developments in our company coincide to a great extent on each of these points. I will confine my discussion to just three of the trends with particular reference to the part which operating management must play in the successful solution of the problems.

First, the trend towards raising the incentive opportunity from the present established 35 per cent level to a higher one. This trend has been brought about in many diverse ways such as:

a. Loose incentives established either through insufficient knowledge of the true equipment capacity or on poor operating methods.
b. Incentives not being kept up to date as changes in equipment and methods (often minor in themselves) were installed.
c. Actual nonacceptance or disbelief of the 35 per cent policy.
d. Pressure from operating supervision.
e. Errors of industrial engineering.

A single incentive in one area of a plant paying an abnormally high rate of return becomes the level at which all other earning rates are "targeted" in the minds of workers already on incentive or about to be placed on incentive. The measure of equity tends to revolve around the plan yielding the highest rate of return.

We must continually keep in mind that "35 per cent" means well over $0.83 per hr for the worker in average job class 8. A single percentage point sounds small but amounts to an average of over $4.00 per month for each employee covered by the incentive. A sizable item of cost results when the number of employees involved is considered.

We can all exert an important influence in avoiding incentive inequities, and it is only through complete understanding and co-operation between the operating people and the industrial engineers that incentives can be kept in line.

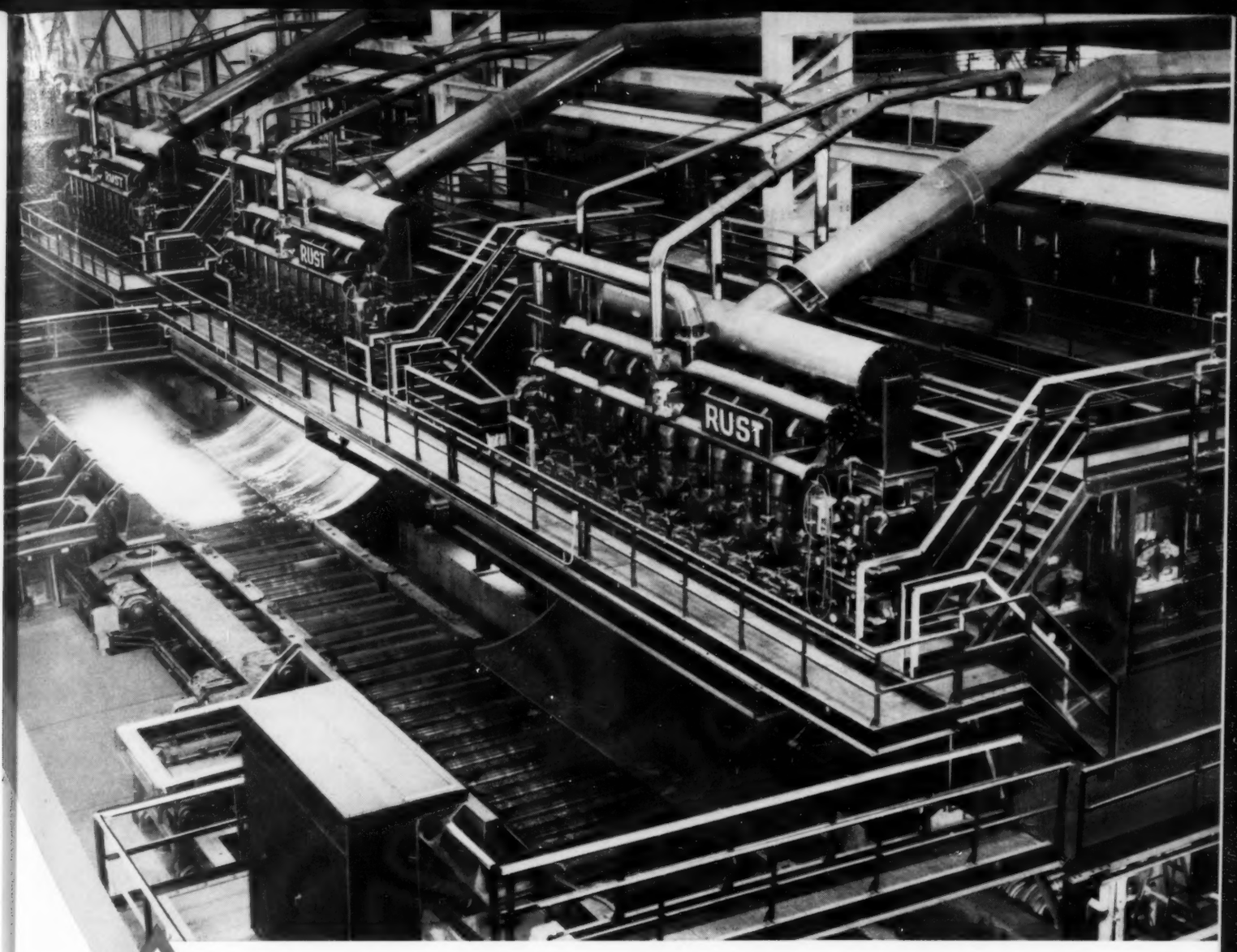
The second trend I would like to discuss is increased incentive coverage. This is only natural and, in many respects, more coverage means fewer inequities and lower costs. This is true, however, only to the extent that each incentive is designed to reward additional effort and added contribution towards increased production. The standard hourly wage rate was established to eliminate inequities and has been accepted as being the proper rate of pay for each job. Adding to this rate of pay without receiving additional output is upsetting the excellent results obtained in the conclusion of the inequity program.

If the added coverage is only a subterfuge for an increase in wages, such a trend is only multiplying inequities and building up a set of problems which could be extremely costly and difficult to resolve. Although a problem may be solved immediately by such increases, many more problems are raised for the long run.

The third trend mentioned by Mr. Cramer which I would like to discuss is the elimination of incentive earnings differentials. I personally have not seen enough evidence of action in this area to give credence to an actual trend in our industry, although I agree entirely that action in this area is necessary to achieve an equitable wage structure.

Certainly, it does not seem equitable that a person not even on the payroll today be hired at a future date on a job carrying an out-of-line differential brought about by a new incentive plan replacing an old plan several years ago and the new employee be paid this out-of-line differential. We agree that employees on the job at time of replacement do have an equity in the difference in earnings between the old and the new plan. Perhaps the solution lies in handling these cases as described by Mr. Cramer in the textile and electronics industry.

In conclusion, let me repeat Mr. Cramer's statement that, with better understanding, acceptance of sound and equitable policies, and the support of strong organization leadership, incentive trends can be channeled to the benefit of all. Our common goal should be one of sound incentives which will continue to bring high productivity and low costs to our industry. Support of strong organization leadership includes the support of each of us. ▲



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Slab Reheating Furnaces

For KAISER STEEL CORP. 86″ Hot Strip Mill, Fontana, Calif.

THREE completely AUTOMATIC gas-fired RUST FURNACES, designed and constructed for Kaiser Steel Corporation's Fontana Works. Each furnace is designed to heat cold slabs to rolling temperatures at a rate of 150 tons per hour. Internal dimensions of furnaces: 24′ wide x 100′ long. Metallic recuperators minimize fuel consumption. This zone-fired type of Rust furnace is used by virtually all strip mills throughout the world. Consult us about your furnace requirements – melting, reheating or heat treating.

THE WHOLE JOB IS ONE JOB WITH A "RUST PACKAGE CONTRACT"

One contract covers everything from original idea through furnace start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

RUST FURNACE COMPANY

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Pioneers in Furnace Design

F-24

Automatic Tuyere Control Improves Blast Furnace Operation

A NEW system for balancing the flow of "blast" air through the tuyeres of a blast furnace was recently introduced by B-I-F- Industries, Inc., of Providence, R. I. Enriched air, heated to 1800 F and blown through nozzles in the base of the blast furnace, controls the temperature and burning rate of the charge and provides oxygen necessary to burning. With automatic tuyere control these difficult-to-control air blasts are made uniform despite back pressure and "channeling." The results are fewer hot spots and burned furnace linings, lower blowing costs, and preventing valuable fines from being blown out the stack.

Tuyere control is needed because during furnace operation, back pressures frequently occur, creating "channeling," with the result that air blasts are unequal. This variation in blasts causes uneven burning, with hot spots developing along the furnace wall, loss of fines, burned linings and high blowing costs.

The controlling system as designed by B-I-F- Industries, Inc., consists of a flow nozzle, a balanced flow transmitter, a stacked diaphragm controller, a strip chart recorder, a 4-way valve positioner and a ceramic-lined butterfly valve—one set for each tuyere.

All control stations are cascade control systems, receiving the same flow control signal and master set point. In this way, the flow of air through all tuyeres is equal. However, variations in charge, burning conditions and furnace back pressure frequently occur. When they do, the automatic tuyere control system goes into operation, automatically maintaining equal and uniform air blasts into the furnace.

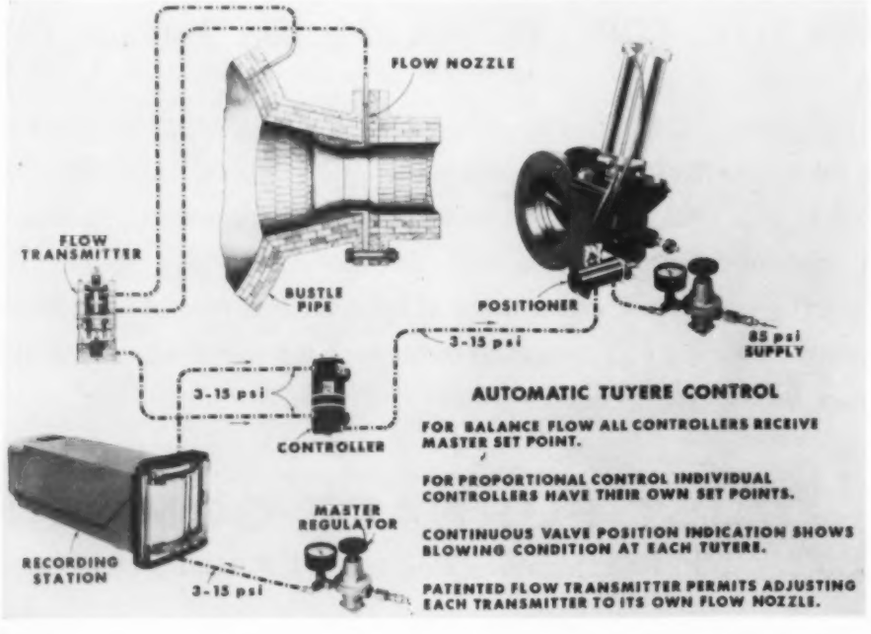
In operation, if a tuyere channels (receives a sudden rush of air because of less back pressure), air flow increases in that nozzle. This increase causes the regulating controller to throttle the butterfly valve and bring the errant tuyere back into line.

On the other hand, if the tuyere suddenly plugs up, the controller will open the butterfly valve to permit more air flow, unplugging the nozzle. Suppose the tuyere remains plugged? In this case, the butterfly valve opens to maximum position and the automatic control system takes over to increase the bustle pipe pressure. At the same time, the control system causes all unplugged tuyeres to throttle back, delivering maximum air to the plugged nozzle, unplugging it.

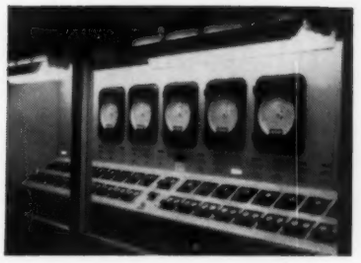
Once the tuyere is free, the automatic control system will throttle all butterfly valves back to master set point for delivering a uniform air blast to all tuyeres. As an added precaution, a high pressure alarm system prevents the bustle pipe pressure from rising too high. If the nozzle refuses to unplug despite all automatic efforts of the system, its controller removes it from the system by switching from cascade. This can be accomplished automatically.

As an additional refinement on the system, a master signal control system is added. This continuously trims the master set point to keep all butterfly valves as wide open as possible, keeping blowing costs to a minimum. ▲

Figure 1 — Schematic illustrates operation of automatic tuyere control.


FLOW NOZZLE
FLOW TRANSMITTER
BUSTLE PIPE
POSITIONER
3-15 psi
85 psi SUPPLY
3-15 psi
CONTROLLER
AUTOMATIC TUYERE CONTROL
FOR BALANCE FLOW ALL CONTROLLERS RECEIVE MASTER SET POINT.
FOR PROPORTIONAL CONTROL INDIVIDUAL CONTROLLERS HAVE THEIR OWN SET POINTS.
MASTER REGULATOR
CONTINUOUS VALVE POSITION INDICATION SHOWS BLOWING CONDITION AT EACH TUYERE.
RECORDING STATION
3-15 psi
PATENTED FLOW TRANSMITTER PERMITS ADJUSTING EACH TRANSMITTER TO ITS OWN FLOW NOZZLE.

HAGAN NEWSLETTER
Behind the Panel



3,850,000 LB/HR BOILER (WORLD'S LARGEST) TO HAVE HAGAN CONTROLS

TVA's Widows Creek Station will have a twin furnace boiler powering a turbo-generator rated at 500,000 KW, and is expected to go in service in mid-1960. The Hagan Control package for this giant boiler includes: combustion, 3-element feedwater and air heater temperature control systems, all principal metering, panel boards and automatic data processing system. The data system, supplied by Hagan's Kybernetes division, will continuously monitor 475 variables, and log 90 of these. In addition, any group may be selected for trend logging or demand logging. Each of these special functions may be initiated without interrupting the basic scanning which monitors for off-normal conditions. Of primary interest is the fact that the Kybernetes system is capable of adding integrating and computing control functions, so that completely automatic station operation is a future possibility. (Item E-1)

PERFORMANCE GUIDES SELECTION OF SINGLE CONTROL SUPPLIER

A major gas turbine manufacturer chose several manufacturers to supply control components, among them Hagan. As operating experience accumulated, it became evident that the Hagan components were superior in terms of reliability and accuracy. More and more Hagan components were specified, until today, the whole control package on every turbine is made up of Hagan equipment. Included are shockproof ratio totalizers, gas turbine thermostats, hydraulic toggle valves, sequential totalizers, and other Hagan components specifically engineered for the type of rugged service encountered by both stationary and mobile gas turbines. (Item E-2)

ALLOYS DEMAND PRECISE TEMPERATURE CONTROL DURING SOAKING

Soaking pits which are used for the heating of alloy steels must have a precision temperature control. The billets must be brought up to an exact temperature at a controlled rate; any over- or under-shooting of the desired temperature will have an adverse effect on the characteristics of the alloy. That is why Hagan fuel-air ratio, pit temperature and recuperator temperature controls were installed on a series of six new pits recently built by a major steel producer. The pits have been in service for nearly a year, heating alloy steels primarily, and operators are pleased with the performance of the Hagan controls. Required temperatures are reached at the proper rate, there is absolutely no over-shoot, and maintenance of the control equipment has been merely routine. (Item E-3)

WHEN "START-UP TIME" IS AN IMPORTANT FACTOR

Getting an installation going after construction is complete usually depends on how fast the control system can be put into operation. And that in turn usually depends on the skill and experience of the field engineer in charge. At a recent Hagan installation involving complete combustion control systems for twelve open hearth furnaces, sixty days of service time was included in the contract. The twelve furnaces are in excellent operation, and the total service time used amounted to only fifteen days. There are two reasons for this: one is that the Hagan field service engineer knew exactly what he was doing, and the second is the elegant simplicity of Hagan control components and the fact that they are shop calibrated and ready to go to work as soon as installed. This allows operating personnel to become familiar with the simple adjustments quickly and easily. At another installation which included combustion control, feed water control and principal metering on three large boilers, the superintendent stated that the thing he liked best about the systems was the ease with which they went into operation, and the excellent services rendered by the Hagan field engineer in charge. (Item E-4)

KYBERNETES DATA LOGGING SYSTEM FOR REFINERY

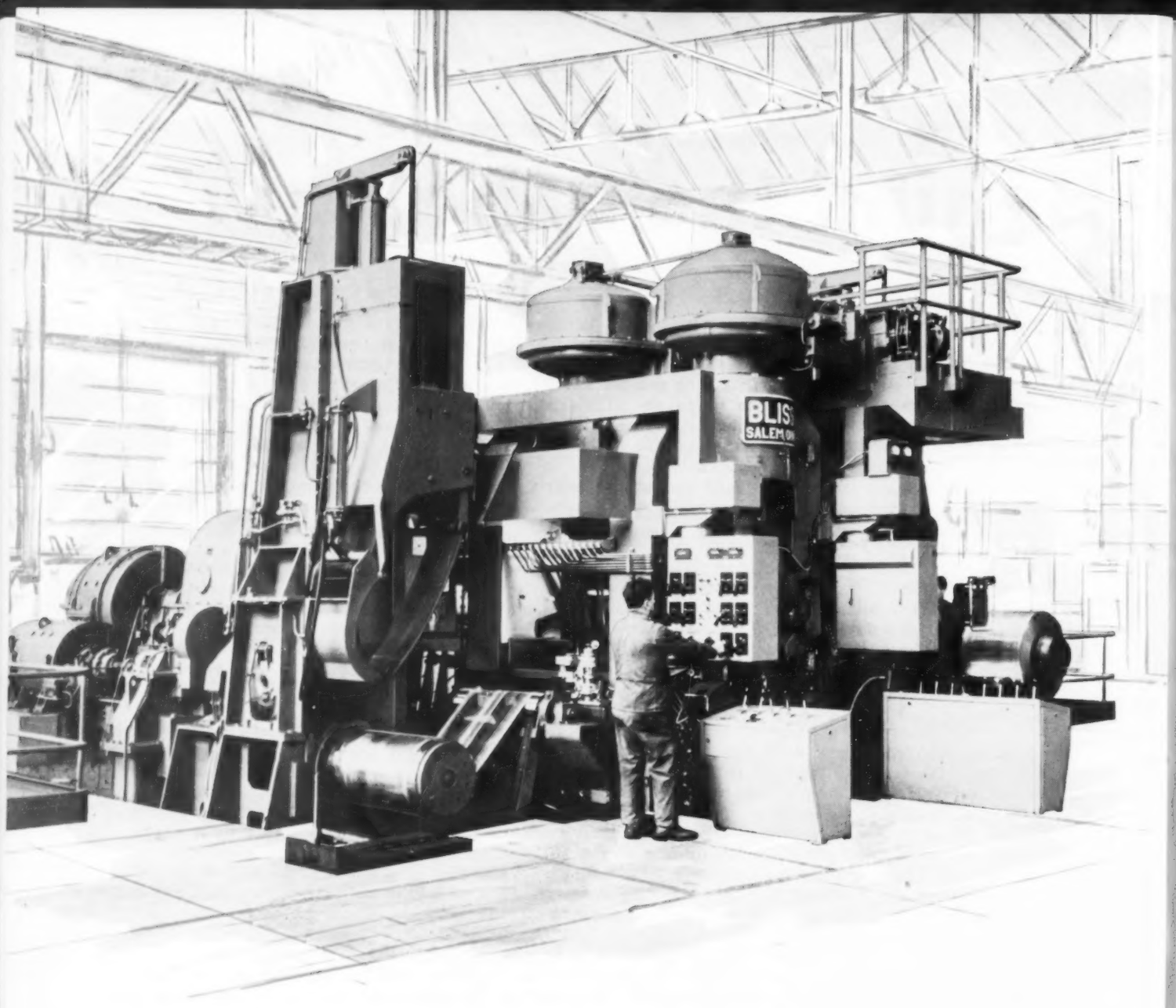
Scanning and providing visual readout of 100 temperature points in a catalytic reformer, this data system, designed and built by Hagan's Kybernetes division, can be expanded to accommodate readout of flow and pressure data. Installed to provide operating experience with data loggers in refinery operation, the system is seen as being the first step in the use of complete computer control. (Item E-5)

HAGAN CHEMICALS & CONTROLS, INC.

Hagan Building, Room 704, Pittsburgh 30, Pennsylvania
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

If you would like more information on any of the above items, check the appropriate box below.

☐ Item E-1 ☐ Item E-2 ☐ Item E-3 ☐ Item E-4 ☐ Item E-5



New Bliss reversing cold mill for France's largest producer of brass strip

Near Paris, Compagnie Française des Métaux, France's largest producer of brass strip, rolls brass on its new Bliss 6½" & 30" x 36" four-high reversing cold mill.

The mill, which can attain a speed of 1,000 fpm is equipped with the auxiliaries necessary to produce brass strip of the highest quality, in widths up to 30" and thicknesses as fine as .0028".

The brass thus produced is used throughout French industry... for automobiles... for defense... for hard goods... for jewelry... for the myriad needs of free Europe.

The Paris installation of Compagnie Française des Métaux is the latest of many such Bliss mills being operated throughout the world, rolling all kinds of ferrous and non-ferrous material. To learn of other Bliss-engineered installations, write for a copy of our 84-page Rolling Mill Brochure, Catalog 40-B.

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Iron Cement Reduces Furnace Downtime

PITTSBURGH Steel Co. found that use of an iron cement in its blast furnace improvement program saved not only the cost of a new top ring casting for a revolving distributor but also two weeks time.

By using 2500 lb of iron cement, as a filler and a grouting material, Pittsburgh Steel was able to save approximately $35,000, the cost of new castings, and to return the furnace to production sooner.

Blast furnace improvement is one of the final stages of Pittsburgh Steel's $111,000,000 expansion program, launched in 1950 to modernize and expand the company's steelmaking and finishing facilities.

The savings were accomplished during a relining job for No. 2 blast furnace at the Monessen, Pa., Works. No. 2 is a veteran producer of pig iron, credited with a total output of 7,000,000 tons since its installation in 1913. Its daily production averages 750 tons.

When relining of No. 2 was undertaken in 1957, it was found that the bracket castings supporting the revolving distributor ring had become badly warped. As a result, a new revolving distributor that was to be installed did not seat properly. Scallop-type warping on the bracket coatings created voids up to 1 in. in thickness on the ring coating which measures 6 in. wide by 54-ft circumference. The void had to be eliminated to prevent furnace gas leaks.

There were two possible solutions: install new top ring support castings, or fill the voids. Since the latter was obviously the more economical solution, saving the cost of castings and further delay in returning the furnace to production, Pittsburgh Steel decided to attempt a filling job first.

The filler selected had to withstand temperatures of 800 F and above, and pressure of 120 in. water gage. It had to perform in such a way that the fill would be absolutely gastight.

The job was accomplished with iron cement, Smooth-On No. 2, made by Smooth-On Manufacturing Co., Jersey City. Although the area involved, of course, cannot be examined until No. 2 blast furnace ends its present campaign, the filler's performance since No. 2 was relighted indicates that the application has been successful.

Pittsburgh Steel was faced with another maintenance problem in another area of the same furnace. This time the huge base support columns were involved. These columns measure 42 by 60 in. at both the base and top. It was found that five of the 12 columns, base and top plates, were warped, again posing the problem of seating.

Ordinarily filling the voids and leveling up the columns would have called for a grouting job. In this case, however, the voids were actually too narrow to permit a good grout.

Again, Pittsburgh Steel decided to try an application using iron cement between the metal surfaces. This application was also successful.

With its support columns leveled and its new top ring casting fitted gastight, No. 2 blast furnace was returned to full production without the costs and downtime usually required for repairs of this type. ▲

Figure 1 — The iron cement was used in two areas in two different ways. It was used to seat and level the support column seen in the center of this figure and four others which had become warped at the base and top. It was also used to create a gastight fill higher up, where the top ring casting carries a revolving distributor.

Morgan presents another FIRST...

DUAL CAPACITY HOIST (patent applied for)

Capable of performing the functions of two hoists, this new Morgan Dual Capacity Hoist combines either function in a single unit. Heavy loads are lifted at slow speeds, light loads at high speeds. One hoist drive does the work that previously required two completely separate drives.

Morgan engineers developed the dual capacity hoist, by separating the hook block into two parts and altering the rope reeving through them. The shift from low to high speed hoisting is done quickly by mechanically separating the dual block and disengaging a portion of the reeving. On a given hoist, reeving can be modified to provide 2:1, 3:1 or 4:1 ratios.

Basically, the dual capacity hoist employs the same mechanism as a single hoist, thus allowing hook approaches and cost comparable to that of a single hoist trolley. Get in touch with Morgan and an experienced crane engineer will explain this system in detail.

THE MORGAN ENGINEERING CO. *Alliance, Ohio*

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, blooming mills, structural mills, shears, saws, auxiliary equipment and welded fabrications.

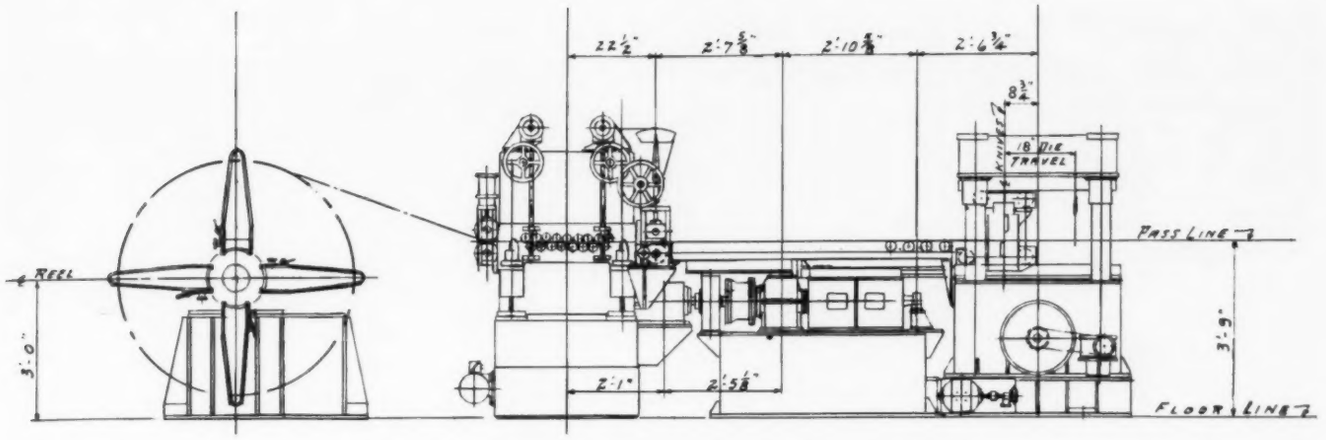


Figure 1 — General arrangement of die shearing line.

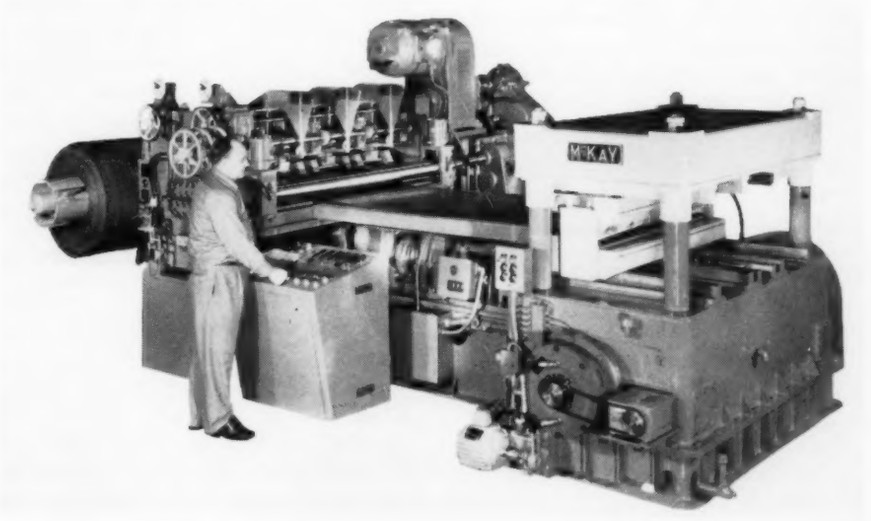
Flexibility Designed Into Die Shear Line

A NEW shear line recently introduced by the McKay Machine Co. of Youngstown, Ohio, is especially designed to give a flexible type operation in an economical package unit. The line is a die shear line which is built to handle coiled metal in most thicknesses and in any width. Among the outstanding features of the line, known as the McKaymatic die shear line, is that it is applicable for use wherever sheet metal is used regardless of quantity of individual sheet sizes. Key features in such applications are flexibility, accuracy and high production. Because of the flexibility feature, the line can be used by many fabricators where it was previously difficult to make the setups for various sizes. An electronic control on this line makes changing the length of the cut practically an instantaneous operation, for such changes can be made without slowing down or starting the line. Automatic programming, available as optional equipment, can be made a part of the line giving increased flexibility. Such programming will use standard data processing cards, punched tape, or a series of manually preset length and quantity selectors.

Accuracy is obtained on the line due to an electronic surface measurement device. This consists of a pulse generator on the exit pinch rolls and an electronic counter to control the length of the cut. The operator reads in the length of cut by means of pushbuttons on the standard equipment and as previously stated, automatic programming can be used by setting the cut lengths. On cold rolled products with normal camber conditions the shear line will yield sheets within resquaring tolerances.

The high production obtained is largely the result of the electronic gaging, which allows length changes to be made without slowing down the line. A synchronized traveling die for shearing eliminated the slowdown during the cut and eliminates strip damage which may occur with mechanical length gages when the sheet comes up against a stop. In the cutting cycle the traveling die set accelerates to line speed, cuts and

Figure 2 — Operator sets line program on pushbutton control panel.



returns on anti-friction bearings over hardened steel guide rails. Standard equipment on the shear die includes an air-operated hold-down bar and counterbalances. In addition to standard cutoff blades, the die set can also incorporate notching and piercing tools when such operations are located near the shear cut.

The standard line consists of a roller leveler, a cutoff press, a shear die and a coil holder. The coil holder can be almost any type.

The initial designs which have been built have production speeds of about 200 fpm when cutting lengths of 4 ft and over. If shorter lengths are to be cut, the line speed has to be reduced proportionately.

The line is not designed to compete with the high-speed flying shear line so commonly used throughout the steel industry which will run at speeds up to 500 to 1000 fpm. The cost of this line, however, is approximately $\frac{1}{6}$ to $\frac{1}{5}$ of such flying shear lines with tonnage capacities of probably $\frac{1}{4}$. In applications where scratching may be a problem or where there are many size setups to be made, the line will produce proportionately higher tonnage. It is estimated that about $80,000 minimum is the cost for the line.

Another feature of the line for many applications is that when a backup roll leveler is used, the strip is commercially flat as it leaves the leveler. With no humping or looping to set the metal, secondary leveling is not required and this eliminates the cost of a second roller leveler which is often used on many shear lines.

Lubrication on the line is accomplished through automatic recirculating system. A-c drives and controls are used throughout the line giving a simple design which, in turn, should insure low maintenance. There is no speed matching of line components necessary since regulating loops and variable speed drives are not used. ▲

Automatic Line processes bars at high speed

A COMPLETELY automatic high-speed machine for the continuous cold drawing, straightening, cutting and polishing of bars from coiled rod is now in full production at an Eastern steel mill. Capable of turning out high-quality cold finished rounds, squares, hexagons and rectangular sections in sizes from $\frac{3}{16}$ to $\frac{5}{8}$ in., the entire installation has a high line speed of 200 fpm. In the production of $\frac{5}{8}$-in. rounds, this speed results in an output capacity of 5 tons per hour, based on 20 per cent downtime for coil feeding and tooling changes.

Designed and built by Loma Machine Mfg. Co. Inc., the machine has been installed for the production of cold finished carbon, alloy and leaded steels. Compared to conventional, separate rod drawing, straightening, polishing and cutting-to-length operations, the new single-operation machine offers the following major advantages:

1. Greater output rate—continuous operation at high speed.
2. Reduced labor cost—only one operator required.
3. Improved straightness—stock is straightened in two planes.
4. Perfect concentricity — obtained by straight-line drawing action.
5. Higher surface finish—due to two-stage polishing unit.

The complete line comprises an uncoiler, a pre-straightener, a drawbench, a roller straightener, a flying cutoff, a polishing machine and a discharge table. All components required for the complete sequence of processing operations are interlocked mechanically and electrically into one integrated and synchronized line which is controlled by only one operator.

In a representative finishing operation, coils of hot rolled, pickled and limed rod weighing about 1000 lb are loaded onto the uncoiler or pay-off table of the line, and one end of each coil is pointed on either a swaging or turning machine. The machine operator has ample free time during the run of a coil through the line to point the next coil without requiring the assistance of a helper.

CONTINUOUS DRAWBENCH

The productivity of the "Lomatic" line is largely due to its continuously operating high-speed heavy-duty drawbench which allows a substantial cold reduction to be applied to the material prior to straightening, polishing and cutoff. The drawbench is of rugged design, allowing an 8000-lb continuous pull to be exerted at 200 fpm line speed. The reduction improves the surface quality of the stock and produces a closely held bar size.

The coil of rod resting on the uncoiler is inserted into the five-roll prestraightener. Upon leaving the prestraightener, the stock is pulled continuously through a tungsten carbide die by the back-and-forth movements of two carriages with built-in jaws effecting a reciprocating movement, so that one carriage moving forward pulls the rod through the die while the other carriage moves back. The gripping jaws are closed and opened automatically by an electro-pneumatic servosystem when the movement of the carriage is reversed. The movements of the carriages overlap in such a way that a continuous uniform advance of the stock through the die is obtained. The back-and-forth movement of the two carriages is controlled by cams cut into two rotating drums disposed underneath the frame of the drawbench. These drums are operated from the main motor, which is connected to the drum shaft by a gear drive. Special provision is made for the adjustment of the carriage ways, to obtain the closest possible fit, free of play.

Furnace at Jones & Laughlin's new Basic Oxygen Steel Making Plant

In Basic Oxygen Steel Furnaces
HARBISON-WALKER REFRACTORIES
hold U.S. service and production records

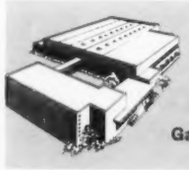
From the beginning of the basic oxygen steel-making process in the United States, two unique Harbison-Walker refractories have contributed significantly to its success. H-W 17-56 brick and H-W OXIMIX monolithic refractory were developed by Harbison-Walker Research specifically for this service when conventional basic brick—both hard-fired and chemically-bonded—proved uneconomical for lining oxygen process furnaces.

Their extensive use—much greater than that of other refractories in the expanding basic oxygen process—is attributable to these noteworthy achievements:

- they made tonnage records in the oxygen furnace plants in North America.
- they have consistently and progressively reduced costs per ton of steel.
- their service life records continue to increase.

The Complete Furnace Lining:

- H-W 17-56 is the special tar-bonded basic brick which forms the complete working lining. Continuing research and broadening experience with modifications of H-W 17-56, promises still further progress.
- H-W MAGNESITE brick laid with strong-setting H-W PERIKLASE Bonding Mortar forms the protective lining against the steel shell.
- H-W OXIMIX is the basic ramming mix which forms both the monolithic hearth of the furnace and the intermediate monolith between the H-W 17-56 working lining and the H-W MAGNESITE brick.



Leadership in refractories through constant research

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HARBISON-WALKER REFRACTORIES COMPANY

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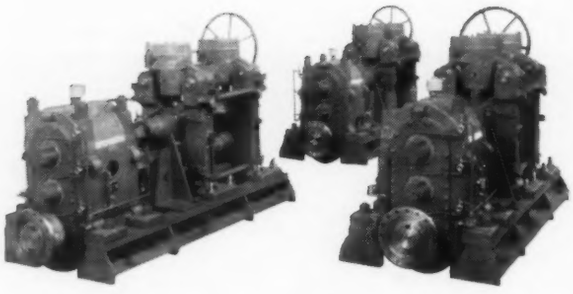
the answers to your steel mill productivity problems are supplied by **BIRDSBORO** *design ideas*



Rising costs can best be offset by a corresponding rise in productivity. The design of automated and semi-automated equipment now becomes more important than ever before. BIRDSBORO, anticipating this trend, has placed considerable emphasis on design in recent years. As a result, ideas have become as important a product as the finished equipment. This application of design ideas through creative engineering has given BIRDSBORO a number of industry firsts and a fine backlog of experience to help in improving your productivity. Contact your BIRDSBORO representative for details of recent steel mill equipment design successes. *Sales Department, Engineering Department and Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

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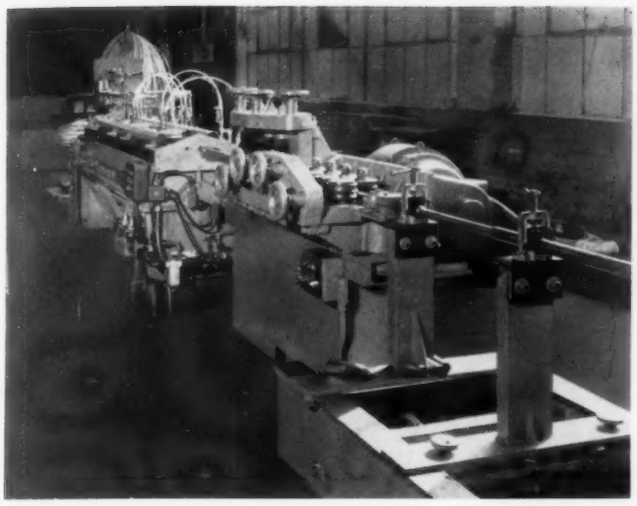


Figure 1 — Continuous drawbench and roller straightener of rod processing line can operate at speeds up to 200 fpm.

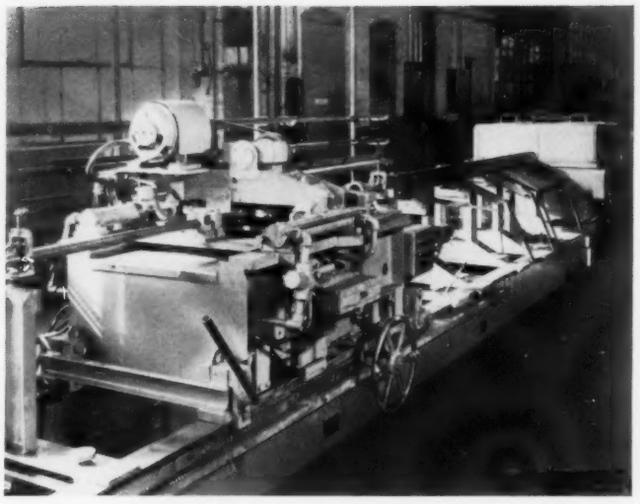


Figure 2 — Flying shear and polishing machine are integrated into the line.

The gripping jaws built into the carriages are of great length and of a special shape, so that they contact the rod from several sides and operate under a low specific pressure. This feature eliminates the risk of surface marks being applied to the material by the pulling action.

The drawing die is mounted in a rigid cast iron die stand. It is lodged in a die holder of spherical shape so that its correct position can readily be adjusted to assure the straight-line advance of the stock through the drawbench. Upon the insertion of a new coil, its pointed end is gripped by auxiliary jaws attached to the first carriage. This point may be very short since the carriage moves close to the die.

ROLLER STRAIGHTENER

The rod emerging from the drawbench passes through a vertical and a horizontal set of straightening rollers mounted in tandem. Each roller straightener comprises eight rollers, four of which are positively driven through gearing by a common motor. The rollers are adjustable by handwheels which actuate the adjusting screws of the roller sliding saddles. Accurately calibrated scales are provided to facilitate the exact setting of the saddles. The rollers are mounted on overhung shafts and are thus not obscured in any way, the operator having a clear view of the stock along the entire length of the straightener. This feature makes the adjustment, operation and changing of rollers very simple. The rollers are made of tool steel, grooved to suit two sizes of stock and can quickly and easily be reversed or exchanged by loosening a nut and removing a horseshoe retaining washer.

FLYING CUTOFF

The rod is cut into lengths ranging from 8 to 25 ft by a flying shear traveling in the direction of and at the speed of the advancing stock. The two cutters of the shear are mounted opposite each other on slides in the shear carriage, which can move back and forth between guides built into the shear frame. The slides which carry the two cutters are linked to levers in such a way that during the forward movement of the carriage, the cutters approach each other until the cut is made. After the cut, they open automatically at the end of the stroke of the carriage and remain open during the return stroke. The advance speed is synchronized with the line speed of the stock, whereas the return stroke is made at a faster speed.

The shear operation is enacted by the rod hitting a length-control limit switch mounted at the entry side of the polishing machine. The previously cut off rod is taken away by the polishing machine at a speed faster than the drawing speed, so that a gap is formed between any two subsequent rods.

The cutoff length is determined by the distance between the length-control limit switch and the flying shear in its rest position. This distance can be varied in accordance with the required cutoff length by moving the entire shear along its supporting bed frame.

POLISHING MACHINE

After cutoff, square, hexagon and rectangular stock is discharged into piling racks, while round stock is further processed in a combined straightening and polishing machine. It passes between two sets of motor-driven disks, disposed at the entrance and exit of the unit. The high pressure to which the stock is exposed when passing between the disks produces a highly condensed and polished surface on the stock. This 20 to 30 microinch RMS finish frequently is preferred to the one obtained by centerless grinding and can be furnished by the mill without involving an additional operation.

Simultaneously, a precision straightening effect is obtained by passage of the stock through three bushings located between the two sets of disks. These bushings are adjustable out of center and cause the spinning stock to bend in all directions, thus relieving any stresses left from the preceding drawing operation and assuring perfect straightness in the finished rod.

DISCHARGE TABLE

The finished product is discharged onto a table mounted behind the polishing machine. This table is sloped slightly towards piling racks placed alongside the table. If the rods roll freely over this slight incline into the racks, it indicates to the operator that they are perfectly straight, and that the straightener is correctly adjusted. ▲

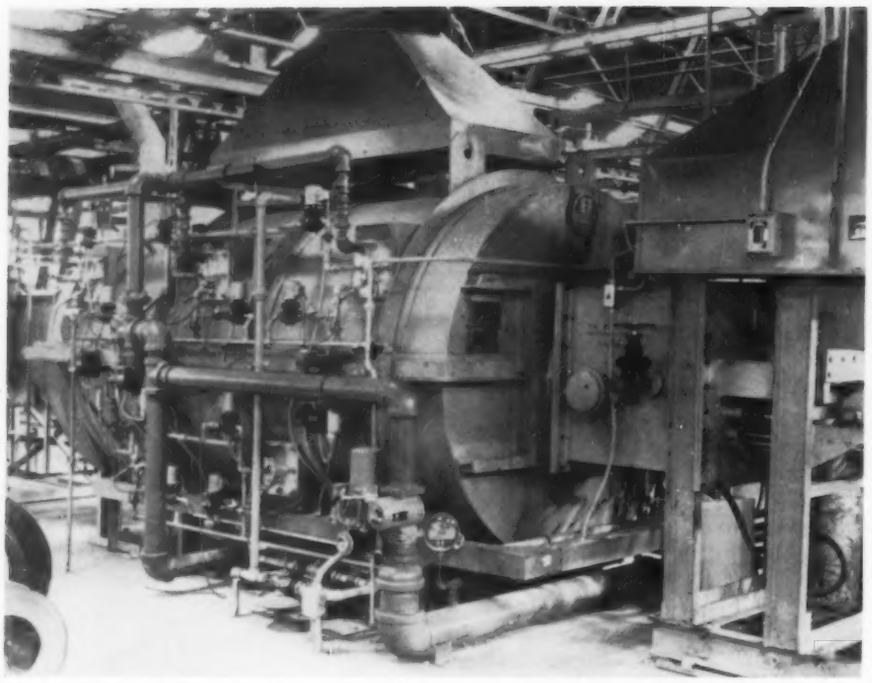


Figure 1 — The main unit, an electric furnace, is especially designed for continuous bright annealing at temperatures up to 2150 F.

Seymour Manufacturing Co.
Enters Stainless Steel Strip Field

NEARLY wiped out by the disastrous floods of August, 1955, The Seymour Manufacturing Co., Seymour, Conn., dug its way out of the muck and debris which covered over 90 per cent of its manufacturing facilities, and, in 1958, launched an ambitious modernization and development program of its long history. This program has rapidly gained momentum during the past year with the installation of new major equipment, the development of product improvements, and the introduction of new products. On March 26, the announcement of another new product, stainless steel strip is a significant addition to the Seymour line.

Seymour strip is available in types 301, 302, 304, 305, 316, 321 and 430. Maximum widths are 17¾ in. in gages down to 0.005 in. and 7 in. in gages 0.005 to 0.001 in. The material may be slit to as little as ¼ in. wide in gages up to 0.020 in., and to a minimum of 1 in. wide in heavier stock.

Most important of the special equipment installed is an electric furnace, equipped with the latest tracking and degreasing facilities. This unit, with "cracked" ammonia atmosphere, produces a bright anneal.

A Sendzimir reversing mill has been equipped with a complete new set of internal rolls with special finishes for rolling stainless steel. The mill has also been modified to produce 3000-lb coils.

A Mesta 4-high rolling mill, installed earlier this year, also plays a prominent roll in the new stainless steel production, contributing greatly to the quality and uniformity of the product. It maintains a high degree of gage control on all sizes of strip and, in addition, permits greater utilization of the Sendzimir reversing mill.

The company's package mill for 7-in. stock has been equipped with a Pratt and Whitney "flying micrometer," for maximum gage control. ▲

Figure 2 — Seymour's "package mill" produces stainless steel gages down to 0.001 in. in widths up to 7 in. A "flying micrometer" rides with the strip and assures maximum gage control.

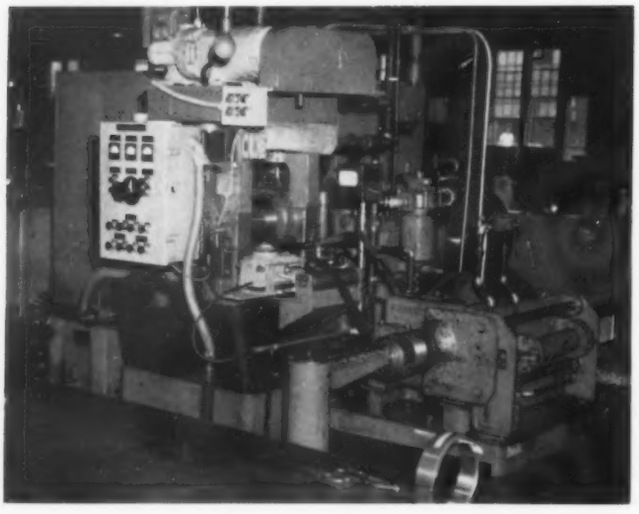
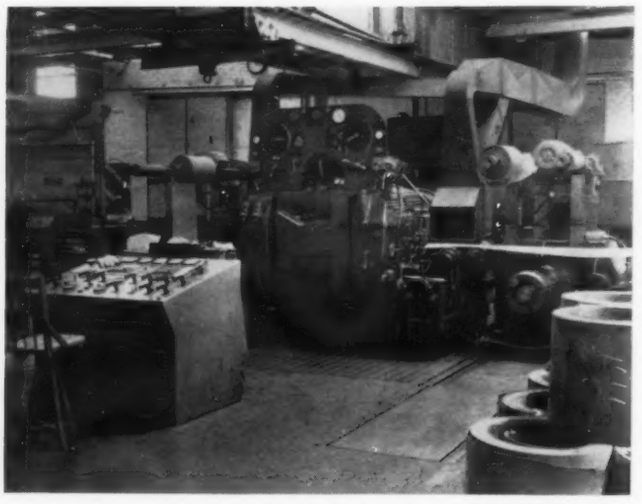
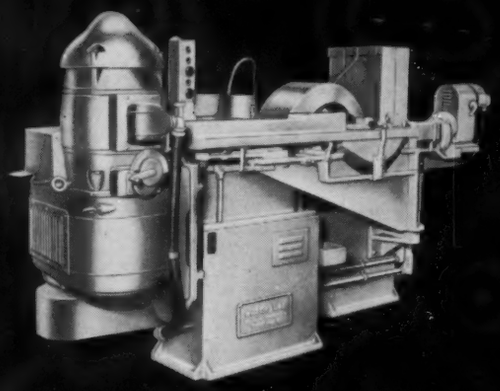


Figure 3 — Equipped with special internal rolls for stainless steel production, the Sendzimir reversing mill produces 3000-lb coils in gages down to 0.005 in. and widths up to 17¾ in.





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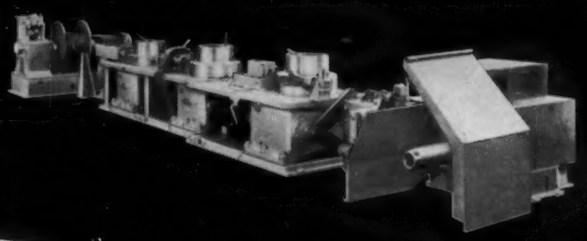

WATERBURY
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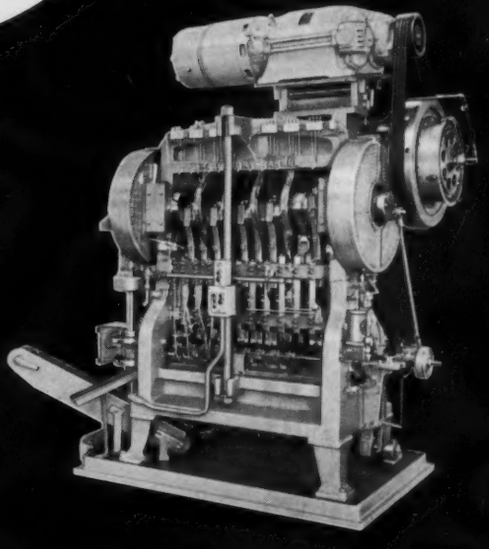
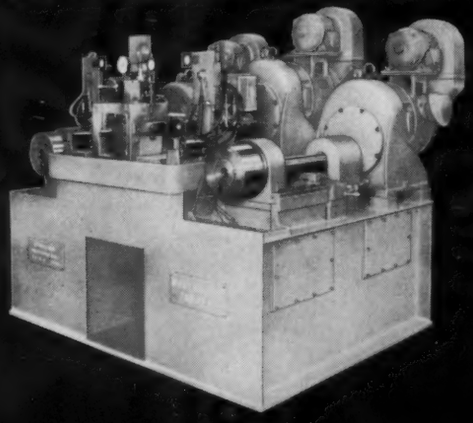


ROLLING MILL
MACHINERY



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WF 58

COMPLETELY

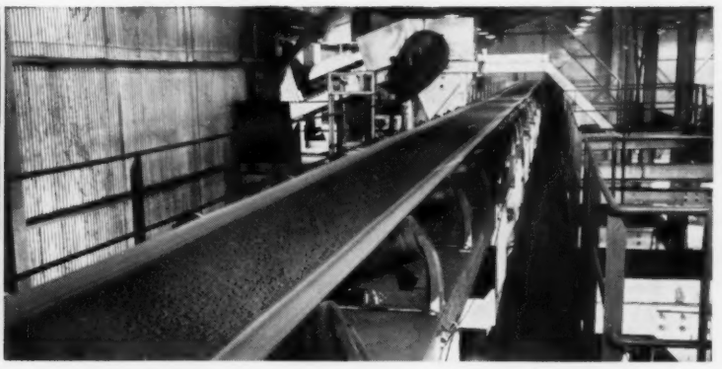
LINK-BELT equipment

OVERALL VIEW of Armco Steel Corporation's new 2400-ton-per-day sinter plant at Ashland, Ky. New facility will be used to agglomerate Labrador iron ore and to reclaim flue dust accumulated from blast furnace operation. Note complexity of Link-Belt conveyor network.

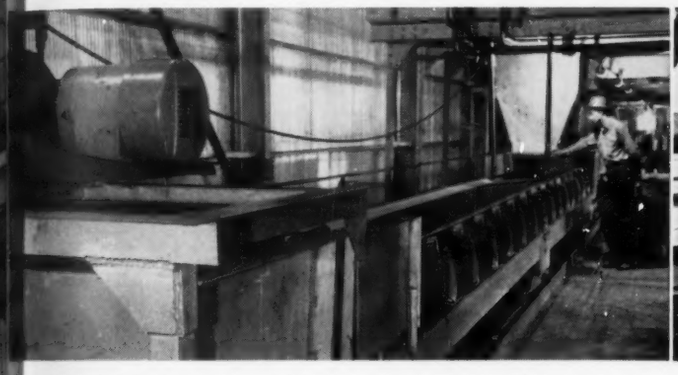
CONVEYORIZED SINTERING PLANT

handles all raw materials as well as sintered ore at the new Ashland sintering plant of Armco Steel Corporation

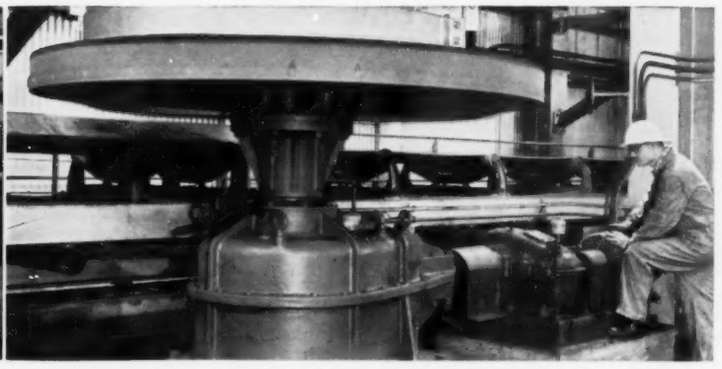
UNLOADING — This Link-Belt car shaker assures rapid and economical unloading of raw materials from hopper bottom cars to track hoppers at yard level.



TRANSPORTATION — 30-inch wide Link-Belt belt conveyor takes ore fines for a 294-foot ride to a Link-Belt shuttle conveyor serving three storage bins.



DISTRIBUTION — Two Link-Belt shuttle conveyors deliver raw materials—coke, flue dust, lime, ore fines or sinter fines—to seven storage bins prior to processing operations.



FEEDING — Seven Link-Belt 96-inch rotary table feeders transfer raw materials (ore, flue dust, return sinter fines, lime, coke breeze) onto Link-Belt belt conveyor.

Armco's new Kentucky plant is this country's first Dravo-Lurgi sintering operation. Due to complex conveying requirements and the limited space available, its layout demanded an unusual degree of materials handling flexibility. To keep materials steadily on the move, Link-Belt conveying equipment was chosen.

As one of industry's largest, most experienced conveying specialists, Link-Belt offers one source for engineering and equipping systems for both new and expanding mills. Systems designed to make the most of existing space . . . handle increased capacities. Our engineers will work with your own engineers and consultants. For full information, contact your nearest Link-Belt office. Or write for Book 2764.

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LOADING — Link-Belt conveyors carry finished sinter ore to loading hoppers for final shipment by railroad car to other plants.

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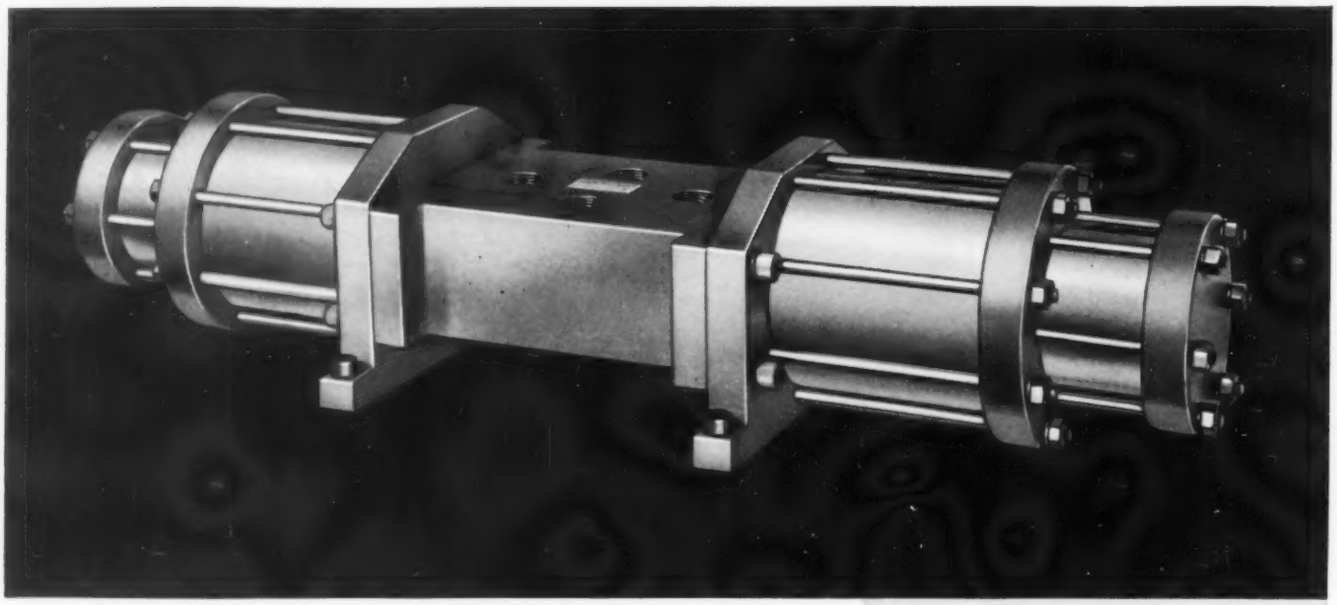

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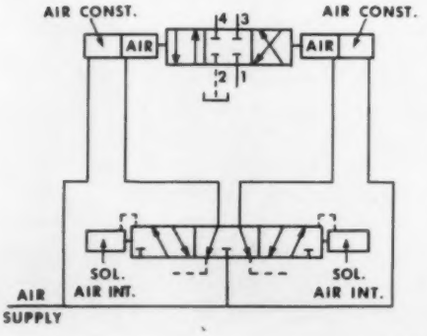

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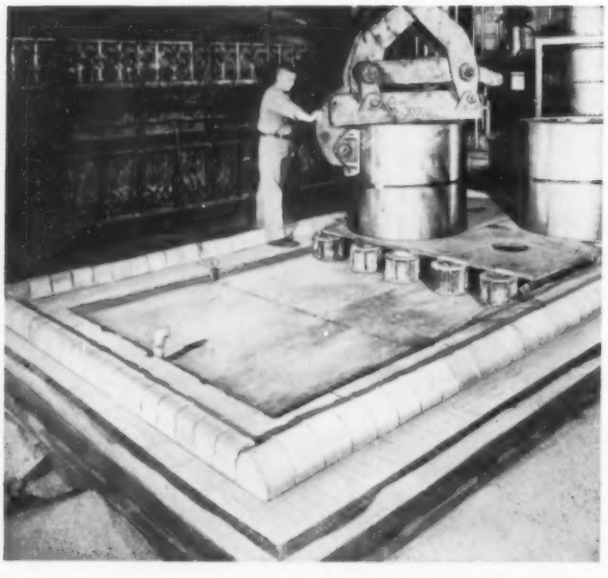
BOX 309, WILLOUGHBY (CLEVELAND), OHIO

Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

Four-stack strip annealing furnace with a capacity of three 30,000 lb coils on a 34 to 36 hr firing cycle, 68 to 78 hr cooling, operating at a strip temperature of 1320 F in a 8.2% CO atmosphere. The base, 9" thick hearth and portions of the curb are cast of B&W Kaocrete-A.

B&W Kaocrete-A resists CO disintegration and sand penetration at Granite City Steel



B&W Kaocrete-A is cast in the hearths and curbs of these furnaces where firebrick refractory was previously used.

Granite City Steel states that both bases have been in use for over three years without any disintegration resulting from the CO atmosphere. In addition, the monolithic structure of this B&W castable refractory eliminates the destructive effects produced by sand penetrating the joints and cracks of firebrick hearths.

For further information on B&W's specialized refractory castables, write for Bulletin R-35.

Strip annealing furnace with a capacity of 70 to 80 tons per charge on a 24 to 48 hr firing cycle, 48 to 96 hr cooling cycle, operating at a strip temperature of 1320 F in a 8.2% CO atmosphere. 4½" lining of B&W Kaocrete-A is used on hearth and curbs.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick
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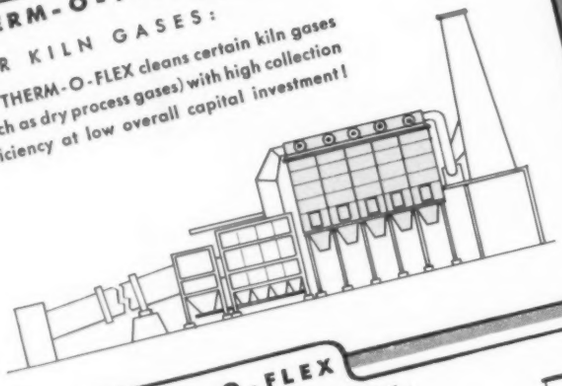
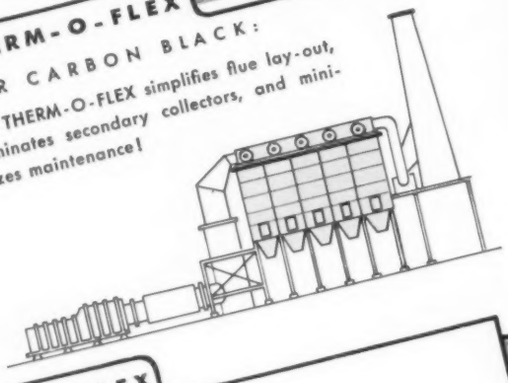


THERM-O-FLEX

FOR CARBON BLACK:

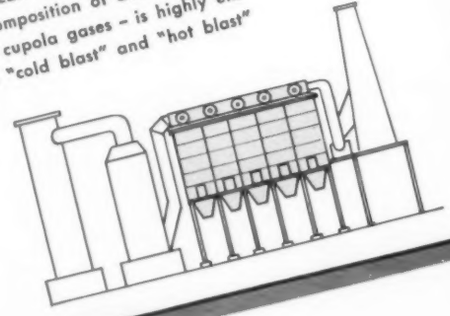
The THERM-O-FLEX simplifies flue lay-out, eliminates secondary collectors, and minimizes maintenance!



THERM-O-FLEX

FOR CUPOLA GASES:

The THERM-O-FLEX is unaffected by the varying chemical composition of dust and fume particles from cupola gases – is highly efficient on both "cold blast" and "hot blast" processes!



Western-Precipitation brings another important new advancement to the gas cleaning field — the THERM-O-FLEX Collector — a filter type of unit with many advantages over conventional filter equipment...

▶ The THERM-O-FLEX features glass silicone treated filter tubes that efficiently handle gases as hot as 550° F!

▶ The THERM-O-FLEX tubes are cleaned *automatically* by intermittent collapsing (not by destructive shaking). This assures uniformly low pressure drop combined with long filter life!

▶ The THERM-O-FLEX has *no moving parts* — nothing to require frequent servicing or replacement!

RESULT — highest collection efficiency combined with lower cost, less maintenance and uniformly low pressure drop on a wide range of applications, a few of which are shown at left.

Let Our Experienced Engineers study *your* dust or fume collection problem — *large or small* — and show exactly how **THERM-O-FLEX** gives new standards of performance at low installation costs. No obligation, of course!

HELPFUL NEW BULLETIN describes multiple Therm-O-Flex savings, outlines applications, technical data. *Ask for Bulletin #F105!*

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Date-line Diary...

April 1

Δ U. S. Dept. of Commerce, Bureau of the Census, reported that shipments of iron and steel castings in January, 1959, amounted to 1,180,349 short tons compared with 1,169,793 tons in December, 1958, and 1,051,711 tons in January, 1958.

Δ American Iron Ore Assn. reported that the consumption of iron ore in the U. S. in February, 1959, totaled 9,699,249 gross tons; receipts of ore at iron and steel plants in the U. S. for February, 1959 totaled 3,045,728 gross tons; stock on hand on February 28 was 52,173,547 gross tons, of 261 blast furnaces, some 215 were in operation on February 28, 1959, compared with 164 in operation on February 28, 1958.

April 2

Δ Auto assemblies in March, 1959 totaled 576,085 cars, which was 20.4 per cent above February, 1959, output, and 61.3 per cent above March, 1958, production.

Δ The Commerce Dept. reported that manufacturers' new orders in February, 1959, reached a seasonally adjusted $29,800,000,000, compared with $24,100,000,000 in February, 1958.

Δ Metal can makers reduced prices on containers used for canning the major portion of the nation's fruit and vegetable pack; American Can said price reductions will save its customers more than $9,000,000 in 1959, and are aimed at discouraging food packing concerns from making their own cans.

Δ The Assn. of American Railroads reported that rail freight loadings for the week ended March 27 totaled 603,755 cars, 0.1 per cent above the previous week and 13.4 per cent above the same week of 1958.

Δ The Agricultural Dept. reported that farm surpluses held by the Government under the price support program rose to $9,100,000,000 on February 28, 1959, an increase of $68,000,000 over the January end total, and compares with total of $7,300,000,000 on February 28, 1958.

Δ The AISI reports that shipments of finished steel products for February, 1959, totaled 6,524,374 net tons, an increase of 5.5 per cent over January, 1959, shipments.

April 6

Δ The AISI reports that the operating rate of the steel industry for the week of April 6 is scheduled at 2,638,000 tons (93.2 per cent of capacity). This compares with 2,638,000 tons one week ago, and 1,308,000 tons one year ago. Index of production for the week is 164.2.

Δ The Bureau of Mines reported that production of Pennsylvania anthracite for March, 1959, was 1,667,000 net tons compared with 1,557,000 in February, 1959, and 1,501,000 in March, 1958.

April 9

Δ The Aluminum Assn. reported that shipments of aluminum sheet and plate in February, 1959, totaled 104,732,000 lb, compared with 103,661,000 in January, 1959. Shipments of aluminum foil for February, 1959 totaled 17,074,872 lb compared with 18,708,376 lb in January, 1959.

Δ The AISI reported that accidents involving time lost from work (or time charged) amounted to 3.21 accidents per 1,000,000 man-hour worked in steel plants in 1958 compared with 3.48 in 1957.

Δ According to the AISI the total number of steel company stockholders in 1958 totaled 1,026,835, an increase of nearly 39,000 over the total on December 31, 1957. The industry has approximately 43 per cent more stockholders than employees; the emp'oyment total in all activities at the end of 1958 was 719,492 wage and salary workers, of whom about 547,902 were employed in the production and marketing of iron and steel.

Δ The AISI reported that the iron and steel industry's payroll for 94.9 per cent of the industry for hourly and salaried employees totaled $333,932,722 during February, 1959, against $335,154,861 in January, 1959, and $249,947,205 in February, 1958. Average hourly payroll cost for wage earners was $3.326, compared with $3.313 during January, 1959, and $3.088 during February, 1958. Fringe benefits amounting to 33.2¢ per hr are not included. Employment during February, 1959, totaled 580,354, an increase of more than 22,000 over January, 1959; average hours worked per week in February was 40.4 compared with 38.1 in January, 1959, and 34.2 in February, 1958.

Δ Retail deliveries of automobiles in March, 1959, rose to an estimated 491,000 cars; sales for the first three months of 1959 totaled 1,324,000 cars, 24 per cent greater than the same period of 1958.

Δ The conclusion reached by a study of the nation's fiscal prospects by the Committee for Economic Development, a private research organization, is that government expenditures will reach $87,100,000,000 yearly by fiscal 1968.

Δ Government figures showed that construction outlays in March, 1959, totaled $3,800,000,000, an increase of $300,000,000 over February, 1959, and $500,000,000 over March, 1958; expenditures for the first quarter rose to $10,900,000,000, $1,100,000,000 above the same period of 1958.

April 7

Δ Price of No. 2 bundles of steelmaking scrap in the Chicago district declined $5 from last week to $23 a ton; quotations on other grades are down $2 to $3 a ton from the week earlier level.

April 8

Δ The Government reported that employment in the month ended March 15 rose to 63,828,000, an increase of 1,106,000 over the mid-February total; unemployment dropped to 4,360,000, down 387,000 during the month.

Δ The Monthly Bookings Index of the Material Handling Institute, Inc., shows the dollar volume of orders in February, 1959, was 124.77 (100 = monthly average, base year of 1954), compared with 115.84 in January, 1959, and 93.49 in February, 1958.

April 9

Δ Latin American and U. S. negotiators agreed to set up a $1,000,000,000 inter-American bank and fund designed to establish new capital investments into countries south of the U. S. border; U. S. is to pledge $450,000,000. Ratification by U. S. Congress and other participants' legislatures is expected.

April 10

Δ The AAR reported that rail freight shipments for the week ended April 4 increased to 590,133 cars, an increase of 13.4 per cent over the like 1958 period, but down 2.3 per cent over the week earlier total.

Δ The steamship *Wilfred Sykes*, flagship of the Inland Steel Co. fleet, started the 1959 iron ore haul on the Great Lakes carrying 16,000 tons of iron ore.

April 13

Δ Custom smelters cut price of copper 1¢ to 33¢ a lb.

Δ According to the AISI steelmakers poured 11,567,000 net tons of ingots and steel for castings in March, 1959, a new monthly record, compared with 9,602,938 tons in February, 1959, and 6,254,622 tons in March, 1958.

Δ The AISI reports that the operating rate of the steel industry for the week of April 13 is scheduled at 2,648,000 tons (93.5 per cent of capacity). This compares with 2,641,000 tons one week ago (93.3 per cent capacity) and 1,285,000 tons one year ago. Index of production for the week is 164.8.

April 14

Δ Custom smelters reduced price of copper 1¢ a lb, to 32¢.

April 16

Δ The Federal Reserve Board reported that industrial output in March rose to 147 per cent of the 1947-49 average; and exceeds the previous high in February, 1957, of 146 per cent.

April 17

Δ The AAR reports carloadings for the week ended April 11 totaled 618,359 cars, up 4.8 per cent from the preceding week and 18.7 per cent greater than a year ago.

Δ Auto assemblies for the week of April 13 are estimated at 135,638 cars, 2 per cent above last week and nearly 85 per cent ahead of the year-earlier pace.

Δ The Government reported, in a survey of productivity, that steel output per man-hour dropped 5 per cent in 1958.

Δ The U. S. Bureau of Mines reported that marketed production of natural gas in 1958 totaled 10,886,280,000,000 cu ft, two per cent over 1957 total; for the fourth quarter of 1958 the total was 2,922,380,000,000 cu ft, 6 per cent over the same period of 1957.

Δ General Electric Co. reports net sales for the first quarter of 1959 amounting to $976,568,000, compared with $964,966,000 in 1958; earnings in 1959, first quarter, were $52,778,000 equal to 60¢ a share, compared with $49,184,000 or 56¢ per share in 1958.

Δ The Aluminum Assn. reported that primary aluminum production in the United States during March, 1959, was 157,189 short tons compared with 142,116 short tons in February, 1959, and 134,020 short tons in March, 1958.

Δ The U. S. Dept. of Commerce, Bureau of the Census, reports that shipments of iron and steel castings in 1958 totaled 13,934,532 short tons compared with 17,922,838 short tons in 1957.

Δ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in March, 1959, were $6,146,000 compared with $2,741,000 in February. New orders for induction equipment for March, 1959, totaled $731,000 compared with $1,147,000 in February, 1959.

April 20

Δ Government economists predict national production of goods and services may reach an annual rate of $485,000,000,000 to $490,000,000,000 in the final quarter of 1959. The President's Council of Economic Advisers officially placed March quarter output at $465,000,000,000 annually, $12,000,000,000 above the rate in the final quarter of 1958.

Δ Prices of steelmaking scrap in Pittsburgh were $1 to $3 under prices early this month, dealer bundles were $25 compared with $26 to $28 earlier this month.

Δ The AISI reports that the operating rate of the steel industry for the week of April 20 is scheduled at 2,683,000 tons (94.8 per cent of capacity). This compares with 2,657,000 tons one week ago (93.8 per cent capacity) and 1,270,000 tons one year ago. Index of production for the week is 167.0.

April 21

Δ A tentative agreement for the merger of Woodward Iron Co. and Alabama Pipe Co. has been reached by managements of the two companies, subject to modification and ratification by directors and approval of stockholders of each company.

Δ Treasury Secretary Anderson reiterated President Eisenhower's January estimate that Federal revenues would total $77,000,000,000 in the fiscal year starting July 1, 1959.

Δ Lead prices advanced ½¢ to 11½¢ a lb in New York.

April 22

Δ Copper prices were advanced by custom smelters ½¢ to 32½¢ a lb.

April 23

Δ The ARCI reports that deliveries of new freight cars in March, 1959, totaled 2797 cars compared with 2486 in February and 5906 in March, 1958. New orders for March, 1959, amounted to 10,795 compared with 1806 in February, 1959, and 193 in March, 1958. Backlog of cars on order as of April 1, 1959, was 35,487 compared with 28,789 on March 1, 1959, and 38,027 on April 1, 1958.

Δ Shipments of iron and steel castings for February, 1959, totaled 1,221,695 short tons compared with 1,180,349 tons in January, 1959, and 911,253 tons in February, 1958.

April 24

Δ The AISC reported that bookings of fabricated steel in March, 1959, totaled 254,773 tons, compared with 294,367 tons in February, 1959, and 195,970 tons in March, 1958; shipments in March, 1959, amounted to 260,490 tons compared with 216,127 tons in February, 1959, and 336,598 tons in March, 1958. Backlog of future work amounted to 1,873,422 tons.

April 27

Δ The AISI reports that the operating rate of the steel industry for the week of April 27, is scheduled at 2,674,000 tons (94.4 per cent of capacity). This compares with 2,646,000 tons one week ago (93.5 per cent capacity) and 1,289,000 tons one year ago. Index of production for the week is 166.5.

Δ Twenty-three ships, 15 of them from foreign ports, moved westward as the St. Lawrence Seaway was opened on April 25 to world traffic.

Δ Crucible Steel Co. of America announced the setting up of a Canadian company to acquire the steelmaking facilities of Sorel Industries, Ltd., Sorel, Quebec, to produce high-speed tool, stainless and other alloy steel products for the Canadian market and for export.

April 28

Δ The Commerce Dept. reported shipments of U. S. goods overseas in March, 1959, at nearly $1,400,000,000, an increase of $187,000,000 over February, 1959, but $67,000,000 under March, 1958.

STEEL COMPANIES FINANCIAL REPORTS—QUARTER ENDING MARCH 31, 1959

	1959 Net sales	1959 Net profits	1959 Earnings per share	1958 Net sales	1958 Net profits	1958 Earnings per share
Acme Steel Co.	$ 40,109,573	$ 1,849,305	$0.67	$28,535,962	$ 439,827	$0.16
Alan Wood Steel Co.	18,450,000	955,000	1.29	12,606,000	32,967	...
Allegheny Ludlum Steel Corp.	70,276,000	4,549,542	1.18	50,454,925	725,900	0.19
Armco Steel Corp.	262,817,183	21,152,038	1.43	196,014,800	9,330,565	0.63
Atlas Steels Ltd.	...	960,084	0.88	...	292,000	0.27
Barium Steel Corp.	8,992,000	114,218	0.11	9,350,000	(422,700)*	(0.41)
Bethlehem Steel Co.	615,929,580	49,567,301	1.06	497,559,327	24,819,490	0.52
A. M. Byers Co.	5,994,546	220,200	0.57	5,302,487	37,050	(0.14)
(6 mos)	11,455,775	495,400	1.34	10,159,031	86,250	(0.23)
Carpenter Steel Co.	...	1,404,335	1.53	...	604,838	0.67
Colorado Fuel and Iron Corp.	...	4,604,840	1.30	...	(1,390,096)	(0.45)
Continental Steel Corp.	...	1,081,030	..	9,255,848	580,839	1.12
Copperweld Steel Co.	33,476,134	1,501,255	1.32	20,817,309	(112,505)	(0.14)
Crucible Steel Co. of America	66,483,130	3,511,206	0.93	44,610,060	172,395	0.05
Detroit Steel Corp.	24,000,000	2,550,000	0.83	13,194,578	(303,678)	(0.12)
Eastern Stainless Steel Corp.	16,190,775	679,219	0.47	9,675,201	249,001	0.17
Firth Sterling, Inc.	5,476,200	101,700	0.06	3,662,200	(281,600)	(0.20)
Granite City Steel Corp.	37,538,764	3,465,763	1.62	28,902,709	2,055,182	0.95
Inland Steel Co.	211,915,807	17,859,090	3.08	150,277,286	7,961,147	1.40
Interlake Iron Corp.	31,725,752	2,119,203	0.95	19,497,198	717,716	0.32
Jessop Steel Co.	6,034,783	456,828	0.76	4,631,075	153,160	0.27
Jones & Laughlin Steel Corp.	236,384,000	15,738,000	1.97	144,584,000	1,657,000	0.17
Kaiser Steel Corp.	61,029,973	3,302,687	0.76	46,293,245	2,049,426	0.46
Keystone Steel & Wire Co.	...	2,431,454	1.29	...	1,277,010	0.68
(9 mos)	...	5,799,333	3.09	...	3,619,069	1.93
Lone Star Steel Co.	20,683,000	2,021,876	0.62	10,249,199	482,638	0.17
Lukens Steel Co.	20,449,381	1,008,394	1.06	24,631,807	1,470,230	1.54
McLouth Steel Corp.	57,802,749	4,663,352	2.71	29,224,971	454,037	0.02
National Steel Corp.	197,659,705	16,504,090	2.20	113,488,782	3,801,426	0.51
Pittsburgh Coke & Chemical Co.	15,595,000	666,000	0.48	10,265,000	210,000	0.09
Pittsburgh Steel Co.	51,298,176	1,370,615	0.66	32,112,512	(968,881)	(0.82)
Republic Steel Corp.	322,657,184	26,844,585	1.71	193,843,837	8,583,506	0.55
Sharon Steel Corp.	34,708,597	590,853	0.54	23,901,809	(283,213)	...
United States Steel Corp.	1,077,588,292	106,585,303	1.86	800,074,024	62,426,679	1.04
Wheeling Steel Corp.	66,562,000	4,471,000	2.08	46,525,000	505,000	0.03
Youngstown Sheet and Tube Co.	184,488,408	11,541,864	3.33	115,338,971	3,576,100	1.04

* Numbers in parentheses indicate losses.

Δ The Aluminum Assn. reported that shipments of aluminum sheet and plate in March, 1959, totaled 129,291,000 lb, compared with 104,732,000 in February, 1959. Shipments of aluminum foil for March, 1959, totaled 19,959,181 lb compared with 17,074,872 lb in February, 1959.

Δ According to the F. W. Dodge Corp. report construction contracts in the U. S. (excluding Alaska) totaled $3,339,934,000 in March, 1959.

April 30

Δ Manufacturers increased their inventories by $400,000,000 in March, 1959; incoming business of manufacturing firms also increased $300,000,000 in March, which was considerably less than the February, 1959, increase of $1,200,000,000.

Δ Consolidated Mining & Smelting Co. of Canada, Ltd. will begin construction immediately at Kimberley, B. C., of western Canada's first iron and steel smelter, the first stage of an integrated iron and steel operation which will cost in excess of $20,000,000.

Δ Steel union officials urge "substantial" pay raise, shorter workweek, other benefits in pact talks including cost-of-living adjustments, increases in week-end premium pay, boosts in unemployment benefits, improved insurance and pensions, liberalized vacations and additional paid holidays, and revisions of grievance procedures.

Δ Arthur B. Homer, president of Bethlehem Steel, reported the company operated at 98 per cent of capacity during April, 1959, compared with an average of 85 per cent capacity in the March quarter.

Δ Copper prices were lowered ½¢ per lb to 32¢ by custom smelters.

Δ Westinghouse Electric Corp. reported for the first quarter of 1959 sales totaling $440,072,000, net income of $14,409,000 equal to 81¢ a share compared with first quarter of 1958 sales of $449,329,000, net income $12,903,000 equal to 73¢ a share.

Δ American Iron Ore Assn. reports that the consumption of iron ore in the U. S. in March, 1959, totaled 11,512,241 gross tons; receipt of ore at iron and steel plants in the U. S. for March, 1959, totaled 3,542,992 gross tons; stocks on hand on March 31 were 38,601,658 gross tons; of 261 blast furnaces, some 224 were in operation on March 31, 1959, compared with 158 in operation on March 31, 1958.

Δ The AISI reported that the iron and steel industry's payroll for 94.9 per cent of the industry for hourly and salaried employees totaled $385,413,953 during March, 1959, a gain of more than $51,000,000 over February, 1959. Average hourly payroll cost for wage earners was $3.336, compared with $3.326 in February, 1959, and $3.092 during March, 1958. Fringe benefits amounting to 33.2¢ per hr are not included. Total employment during March, 1959, totaled 603,635, an increase of more than 23,000 from February, 1959; average hours worked per week in March was 41.0 compared with 40.4 in February, 1959, and 33 6 in March, 1958.

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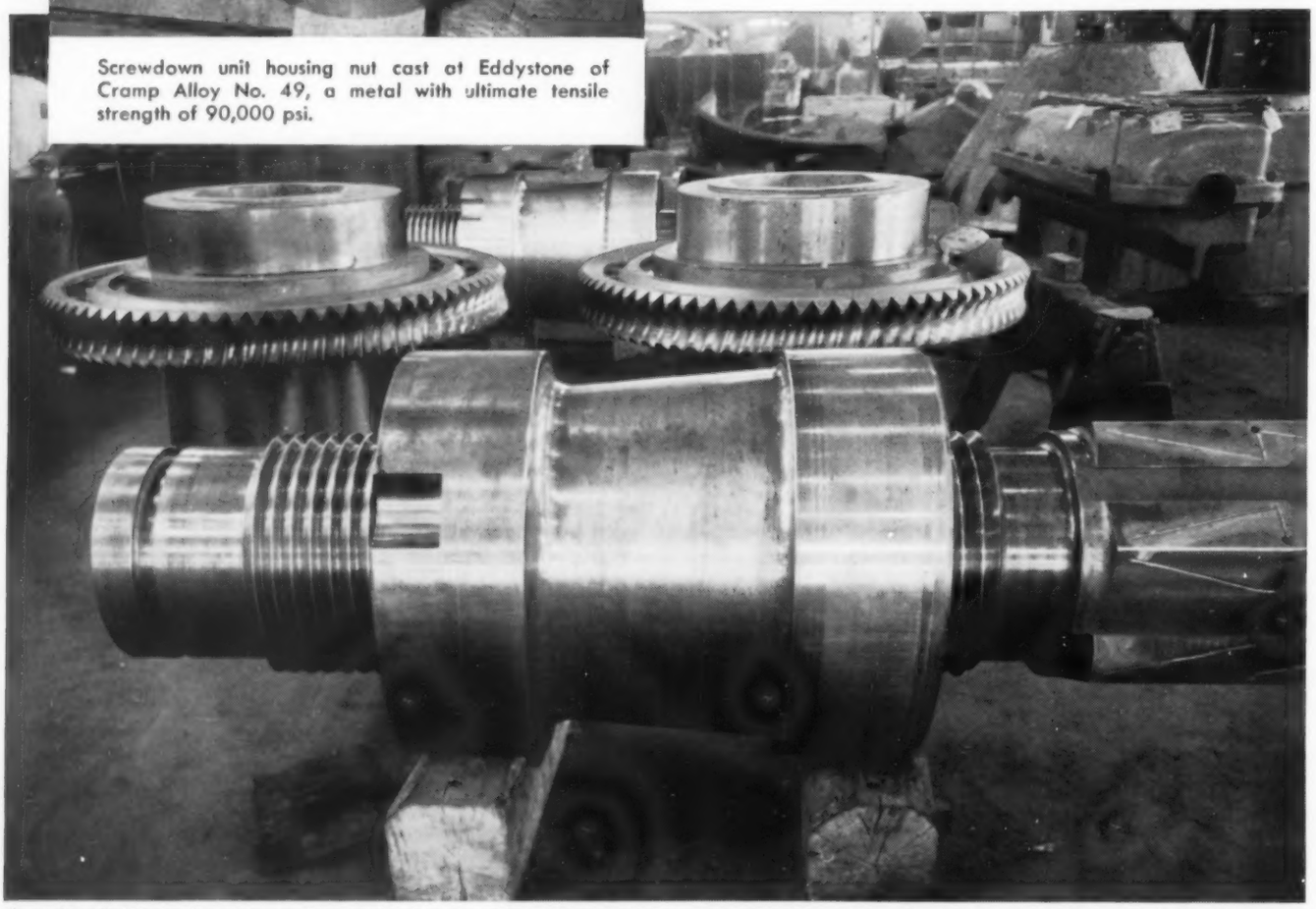

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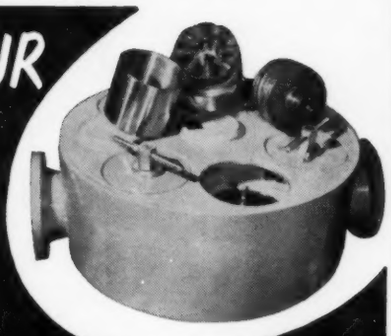

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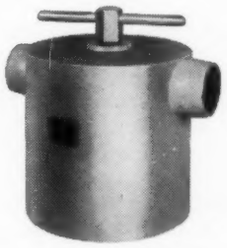

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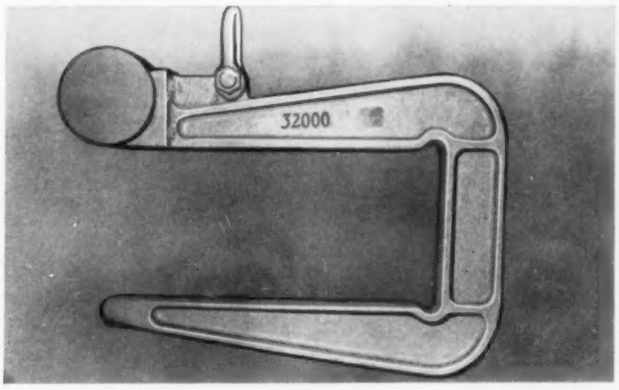

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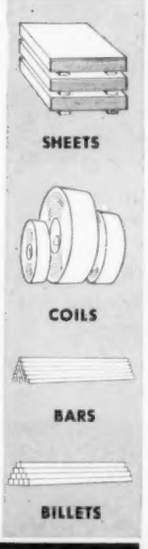

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Industry News...

CONTINUOUS HOT STRIP MILL ANNEALING LINE CONTRACTS AWARDED BY NATIONAL STEEL

△ National Steel Corp. has awarded contracts for major facilities at two plant locations in its new $300,000,000 expansion program. The new facilities will be installed at Great Lakes Steel Corp. and Weirton Steel Co.

The contract for an 80-in. continuous hot strip mill at Great Lakes Steel has been awarded to the United Engineering and Foundry Co. The mill and auxiliary facilities will be housed in new buildings to be constructed on a site adjacent to the present Great Lakes plant.

The new strip mill will have an annual capacity in excess of 3,600,000 tons and will be designed to roll slabs 30-ft long into coils weighing up to 1000 lb per inch of width.

Mesta Machine Co. will be the contractor on construction of a new 45-in. continuous annealing line at Weirton Steel Co. This line will be similar to the present annealing line at Weirton which was also constructed by Mesta. The new facility will have a capacity of 300,000 tons per year and process coils up to 45 in. in width with weights up to 1000 lb per inch of width.

The 80-in. mill at Great Lakes and 500,000 tons of annual ingot capacity are being added to increase steel supply for the Detroit market and also provide the requirements of the new Midwest Steel Corp. plant to be built as part of the expansion program in northwestern Indiana in the Chicago area. Midwest Steel will produce hot and cold rolled sheets, galvanized sheets and tin mill products.

DRAVO LICENSED TO MARKET KALDO PROCESS

The Dravo Corp. has acquired marketing, plant design and construction rights for the Stora-Kaldo oxygen steelmaking process for the United States and Canada.

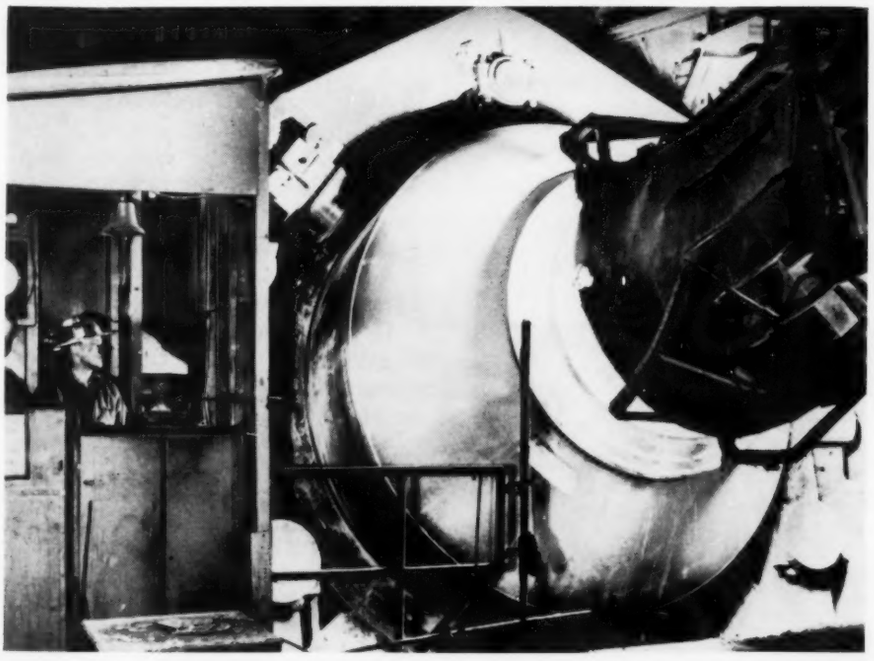
Developed by Stora Kopparbergs Bergslags Aktiebolog, giant 600-year-old Swedish producer of steel, pulp, newsprint and chemicals, the process features the use of an inclined, variable speed rotating furnace for the reduction of pig iron to steel.

The agreement between the two companies enables Dravo to further broaden its integrated services to the steel industry in the United States and Canada. Dravo will be the only company offering these Stora-Kaldo services in the two countries.

Dravo is presently a major supplier of equipment and services for the steel industry. Included are sinter plants, blast furnace blowing systems, power, water supply and lubrication systems, ore and coal bridges, unloaders, towboats, barges, power plants, water and waste treatment facilities and fabricated and erected mill piping.

Although the Stora-Kaldo process was developed primarily for the production of steel from Sweden's high phosphorus iron ore, its ability to produce top quality steel in a broad range of specifications from low phosphorus iron has been proved. Using average United States pig iron with scrap additions, ingot yields in excess of 91 per cent can be expected in most applications, with blowing rates of more than three tons per minute.

It is estimated that a Stora-Kaldo installation in this country or Canada will cost between 50 and 65 per cent less than a new open hearth shop with similar capacity and auxiliaries, and for a 1,000,000-ton plant, should existing open hearth buildings and auxiliaries be used, capital requirements for a Stora-Kaldo installation is estimated at less than $8.00 per annual ingot ton.



TO EXPAND FACILITIES AT ELLWOOD WORKS

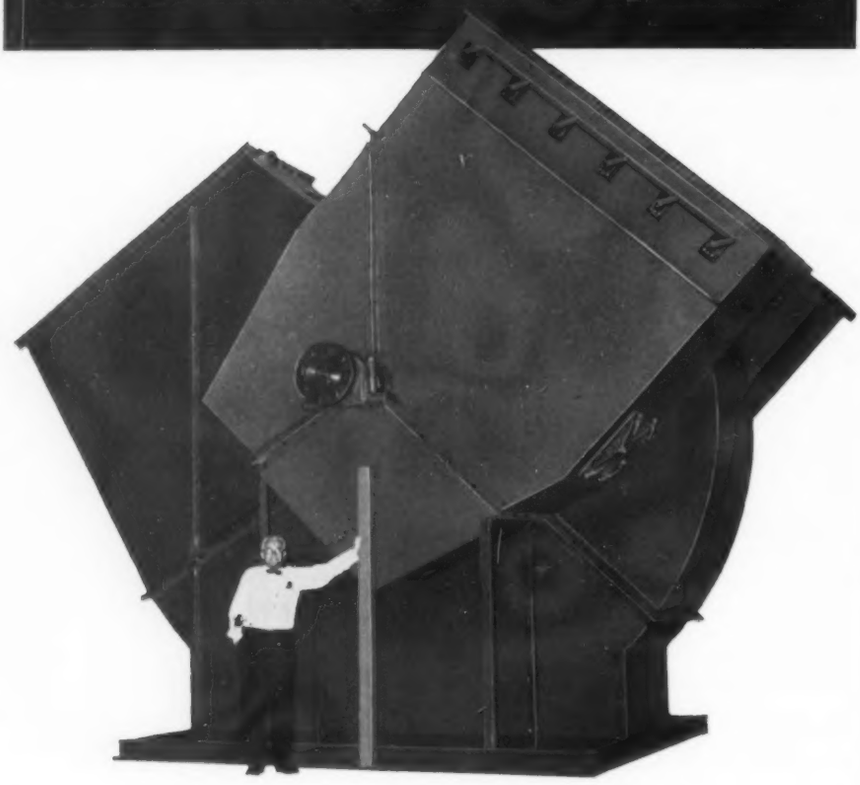
△ Plans for an expansion program which will nearly double the stainless steel tubing capacity of U. S. Steel Corp.'s National Tube Division's Ellwood Works were announced recently.

Two new buildings, adding 40,000 sq ft will be erected at Ellwood Works to house processing, finishing and testing equipment for stainless steel tubing.

Engineering work on the project has been completed. Construction will begin immediately, and will extend over approximately 18 months.

Among facilities to be installed will be a controlled atmosphere annealing furnace, inside and outside surface conditioning equipment, additional tube reducing and bar drawing equipment, cleaning and descaling equipment, and other necessary processing facilities.

Where Severe Applications are Standard



WHIRLEX HEAVY DUTY FANS

TAKE OVER . . . Efficiently

This heavy duty WHIRLEX exhaust fan was custom designed for iron ore sintering machine. The unit is designed to carry hot gases at the rate of 200,000 CFM with 35 in. W.G. static pressure and is complete with scroll liner, cheek plate liner, blade wear pads, inlet louvre control dampers and removable section.

Additional facts and operating data on this and other WHIRLEX custom design fans are available at your request.

Fly Ash Arrestor
CORPORATION
208 North 1st. Street • Birmingham, Ala.

Dust Collectors • Induced Draft Fans
Forced Draft Fans • Exhaust Fans
Self Supporting Stacks • Duct Work

FLY ASH WHIRLEX ARRESTOR

Finishing facilities will include straighteners, abrasive cutoffs and profiling machines. Non-destructive types of testing equipment, including dye penetrant and ultrasonic machines also will be installed.

The materials handling system will include a straddle carrier, monorail and tramrail cranes, and will employ a rack-handling system to minimize the possibility of damage to tubing during manufacturing.

In addition to the processing, finishing and testing equipment, a deep drilling machines will be installed in connection with the present seamless hot mill facilities to provide for the increased stainless steel tubing requirements.

With addition of these facilities, Ellwood Works will produce high quality stainless steel tubing in a complete range of sizes from $\frac{1}{2}$ to 10-$\frac{3}{4}$ in. outside diameter, in a wide range of stainless steel grades.

PRECIPITATOR CONTRACT AWARDED TO KOPPERS CO.

△ Contracts for the construction of major equipment for air pollution control at the Pittsburgh Works of Jones & Laughlin Steel Corp. have been awarded to Koppers Co.

J&L's No. 4 open hearth shop will be equipped with new electrostatic precipitators at a cost of approximately $9,000,000.

J&L's program of smoke abatement at the Pittsburgh Works was initiated recently with the first operational testing of a unit attached to one of the open hearth furnace stacks.

The contracts awarded to Koppers cover the installation of additional such dust-collecting equipment to serve effectively all of the 11 furnaces in the modern shop.

The initial precipitator has been in operation since February 15. Data developed in the operation of this first precipitator are being used in the design of future units.

In the operation of the new precipitators, gases and the dust particles they carry from the open hearth furnaces are cooled and then passed through the high-voltage precipitator. An electric charge is

USE THE ENGINEERING MART

EF Continuous Galvanizing Lines

assure unvarying uniformity of anneal and coating; high daily outputs with no un-scheduled downtime.

TOTAL DESIGN CAPACITY IN EXCESS OF 2,460,000 TONS PER YEAR*

Tailored to meet your specific requirements and incorporating the most advanced techniques, EF continuous galvanizing lines assure users high heating efficiency — accurately controlled cycling — and month after month of continuous, trouble-free, 24 hours a day, 7 days a week operation. You get maximum production — and return — per dollar invested.

The unvarying uniformity of product physicals — the bright even spangle — and the tight bond of the coating, preventing chipping or flaking — assure high market acceptance, and make subsequent forming and fabricating operations more efficient and less costly.

For utmost efficiency and economy on galvanizing operations, and all other continuous, or batch, heat treating of ferrous, non-ferrous or alloy materials, you'll find it pays to consult The Electric Furnace Company heat processing engineers.

* Tonnage output will vary depending upon width and gauge of strip being processed.

EF

THE ELECTRIC FURNACE CO.

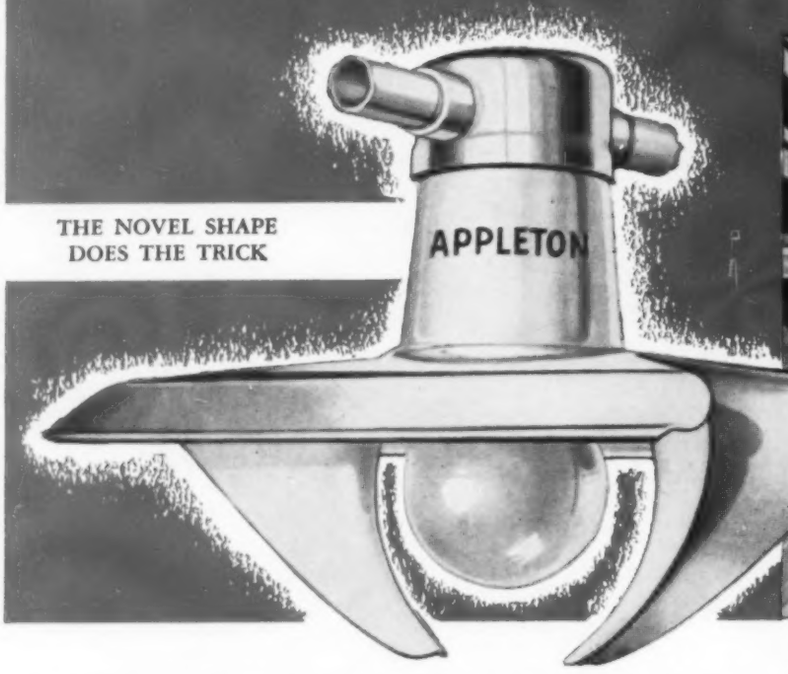
Gas-fired, Oil-fired and Electric Furnaces for Heat Treating any Product, Using any Process, any Hourly Output.

300 West Wilson Street *Salem, Ohio*

Branch Offices in Detroit, Mich., Santa Ana, Calif., and Cheshire, Conn. Canadian Associates, Canefco Limited, Toronto 13, Ontario

THE ONLY FIXTURE SPECIFICALLY DESIGNED FOR

CORRECT SHELF *and* BIN ILLUMINATION



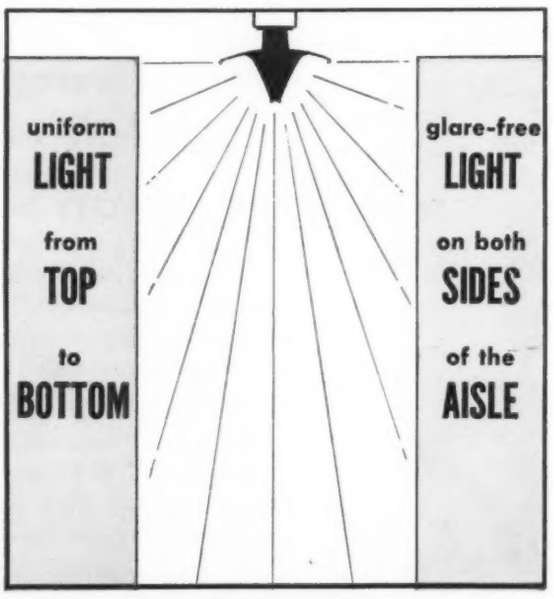
THE NOVEL SHAPE DOES THE TRICK

Stocklites promote good vision, efficient work and employee morale. This stockroom is flooded with controlled, glare-free light to its farthest recesses. Orders are handled faster, more accurately. Costs go down . . . profits up.

FILL ORDERS FASTER, MORE ACCURATELY WITH THE

APPLETON
STOCKLITE

End spotty, harsh, eye-tiring lighting once and for all! Install *Appleton Stocklites* . . . special fixtures that wipe away murky gloom, and let you read labels, small parts numbers, order slips . . . *all the way* from top bin to floor level. The novel shape does the trick . . . prevents wasted light, assures even diffusion, reduces eye fatigue and speeds up order filling with fewer errors. *Stocklites* are attractive, distinctive, permanent fixtures finished entirely in white, vitreous-fired porcelain enamel . . . easily installed, quickly cleaned and extremely corrosion resistant. Inquire now. See how *Appleton Stocklites* give more light, better light from your present lamp wattages.



Sold Through Franchised Distributors Only

REFLECTORS EASILY REMOVED and CLEANED

4 Mounting Styles

Seprable design — no tools needed. Four mountings: pendant, right angle, feed-thru and outlet-box with Seprable keyless or pull-chain sockets . . . ¼ turn release and spring-cushioned for firm contact, longer life. Take 5 standard lamps—50 to 200 Watts.

APPLETON ELECTRIC COMPANY
1729 Wellington Avenue • Chicago 13, Illinois

Also Manufacturers of:

Rely on **APPLETON** *. . . The Standard for Better Lighting*

then directed at the dust particles and they are attracted to a large plate which carries an opposite charge. The dust then can be collected from the plates.

While the specific causes of industrial air pollution are many and varied, the solution of the problems created by emission from open hearth stacks is a major contribution.

COLUMBIA ANNOUNCES THERMAL WORKSHOP

△ Columbia University, Dept. of Mechanical Engineering, New York, N. Y., announces a one-week workshop on "Thermal Problems and Their Solution in the Steel and Nonferrous Metals Industry," June 15 to June 19, 1959, at Columbia University, Room 624 Engineering Building, to be conducted by Professor Victor Paschkis, director of the Heat and Mass Flow Analyzer Laboratory, and his staff. Workshop will cover types of large scale computing devices; basis and description of the heat and mass flow analyzer. It will also cover: elements of heat transfer (conduction, convection and radiation); solidification in molds; continuous and casting; heating furnaces; temperature control; regenerators; recuperators; efficiency, fuel consumption and heat losses. The presentation will be essentially nonmathematical in nature.

Cost is $150 per person, exclusive of room and board. The workshop does not carry academic credit. Inquiries or applications for registration, accompanied by check made out to Columbia University, should be addressed to the Heat and Mass Flow Analyzer Laboratory, Room 624 Engineering, Columbia University, New York 27, N. Y. The workshop is limited to 15 participants.

ANNOUNCES FORMATION OF NEW SALES AGENCY

△ Warren H. Neville has begun a sales agency, located in Riverside, Calif., representing companies in the industrial heating field including: Fennell Corp., J. A. Kozma Co., National Alloy, Acme Bric Co., Homestead Valve, Tate-Jones, and several small refractory lines. He covers all of California, and parts of Arizona, Utah and Oregon.

PV

PLANET VERSATILITY...

RUNOUT SYSTEM *CONTROLS* *40,000-POUND PACKS INDIVIDUALLY*

Planet Corporation's 40,000-pound pack runout system, installed in a large strip mill, is built in 16 individually powered and controlled sections . . . a feature which eliminates damage to edges or corners of the sheets. The runout system starts on the pilers — two prime and one reject. One section is mounted on the platen of each. Four sections extend from each prime piler, three for storage and one for weighing. The reject piler system is the same except it has an extra section which enables the operator to run selected packs off the other side of the piler. The system can handle 40,000-pound prime packs with maximum dimensions of 200″ x 60″ x 54″.

This 40,000-pound pack runout system is more evidence of Planet's versatility . . . its ability to create and build the heaviest of material handling equipment. And like most of Planet engineered equipment, this system is designed to give the producer a better finished product as well as savings in time and labor.

PLAN WITH PLANET If you have a production, materials handling, or automation problem, let Planet demonstrate how its versatile engineering skill, and production and erection know-how can help you. Because of PV, it has paid many leading industrial concerns to "Plan with Planet" . . . it will pay you too. Write or phone today!

PLANET CORPORATION

• ENGINEERED HANDLING SYSTEMS
• AUTOMATION EQUIPMENT
• MILL & FOUNDRY HANDLING EQUIPMENT

1816 SUNSET AVENUE
LANSING, MICHIGAN

96

COMPLETE
QUALITY CONTROL

another advantage of
TM factory-made
alloy sling chains!

Taylor's well-known quality control—gamma ray testing . . . controlled heat-treating . . . professional inspectors—give TM factory-made Alloy Sling Chains the big edge over do-it-yourself types. Patented Tayco Hooks, stress-free links and Taylor's Certificate of Test are other advantages. Get all the facts. Call your distributor or write for Bulletin 13 today!

A full line of welded and weldless chain

CERTIFICATE OF TEST
bears the chain guarantee, proof test and serial number.

S. G. TAYLOR CHAIN CO., INC.
Hammond, Indiana
3505 Smallman St., Pittsburgh, Pa.

Taylor Made CHAIN SINCE 1873

Mr. Neville was formerly associated with the Swindell-Dressler Corp., Pittsburgh, Pa.

ORDERS RECEIVED FOR SUTTON STRAIGHTENERS

△ The Sheffield Division of Armco Steel Corp., Houston, Texas, has ordered a Sutton Engineering Co. 5BC 5-roll rotary straightener for finishing 3 in. to 9 in. heat-treated alloy steel bars as well as oil country drill collar stock. The largest machine of its type, it will be the second largest straightener to be manufactured by Sutton in 45 years.

Also, a mid-western tubular mill has ordered a Sutton 5-roll Model 15 "Syncro-Drive" machine for straightening of cold-drawn mechanical tubing.

NEW RESEARCH CENTER ESTABLISHED BY GE

△ New designs in equipment and components for the conversion of electric power by static means will be explored by General Electric Co. in a new Direct Current Advanced Engineering Center established at Philadelphia, Pa.

Housing several major laboratories using 20,000 sq ft of working area, the center will stress development of silicon semiconductor and mercury-arc power equipment for the electrochemical, steel and aluminum industries.

In addition, extensive work will be conducted in developing power controlled rectifier equipment for application in highly regulated industrial and military d-c power supplies.

The center is an organizational component of General Electric's Low Voltage Switchgear Dept.

According to Albert Hansen, Jr., Manager of the Company's D-C Static Power Development activities, the center will enable General Electric to meet the challenge of expected future demand by industry for direct current power conversion equipment.

Laboratories containing chemical, metallurgical, measurements and crystallographic facilities will be used to develop silicon semiconductor rectifier equipment and circuitry to be incorporated in packaging complete power supplies, including instruments, switches, con-

NEW MODEL
SHEET & COIL
PRINTER

"CHAMPION OF THE LIGHTWEIGHTS"

The advantages of a lightweight sheet and coil printer with all the qualities of Matthews Standard series of mill printers has led to the development of this tested, accepted unit. Check these advantages:

Lightweight

All aluminum printing drum and light weight frame rides lightly and smoothly over the sheet.

Positive action

Wide contact semi-pneumatic drive tires provide positive, non-slip contact and printing action. Gentle, but sturdy.

Uniform ink transfer

A metal transfer roll delivers a uniform film of ink from the fountain to the printing die. Prevents undo wear of the fountain roller and die . . . and saves ink, too.

This unit may have advantages for you. Write today for further details.

JAS. H. MATTHEWS & CO.
3958 Forbes Ave., Pittsburgh 13, Pa.
OFFICES IN PRINCIPAL CITIES

FELLER ENGINEERING
presents

SCHLOEMANN

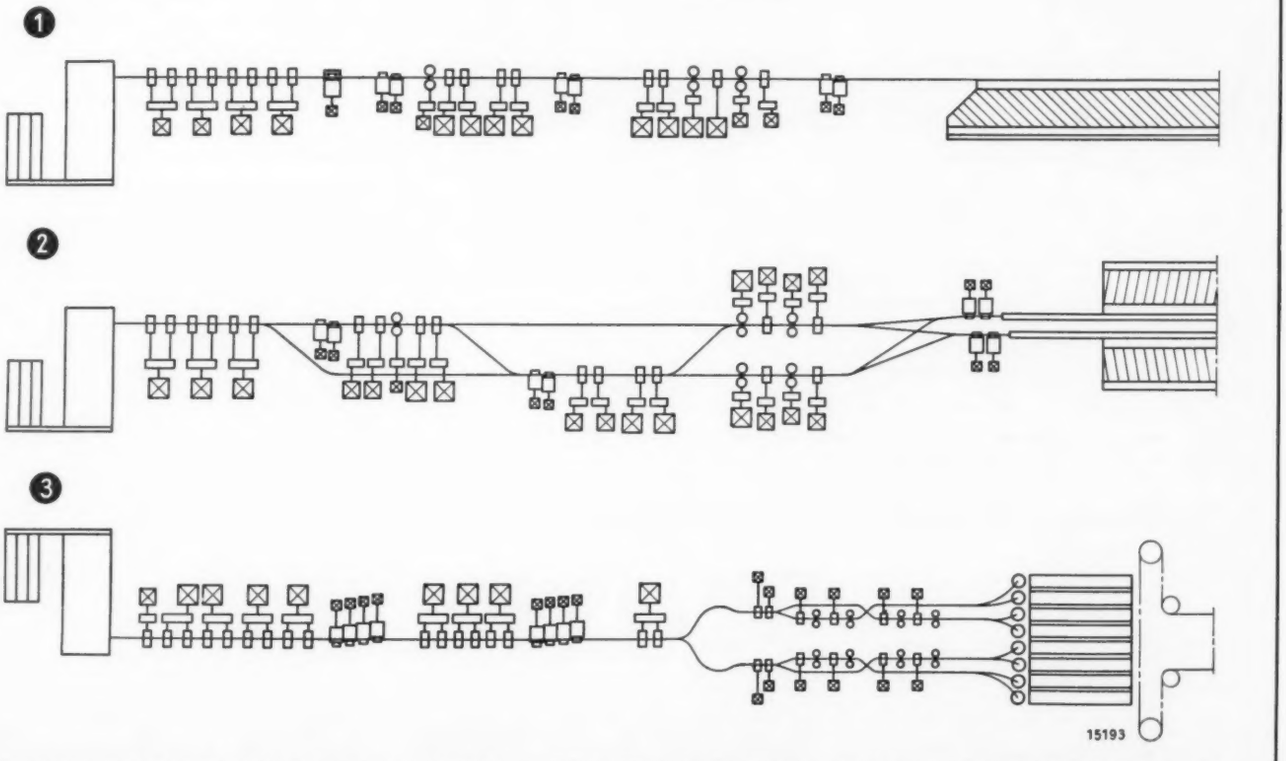
Modern wire rod and merchant mills

Three rolling mills with finishing trains in H/V layout

Close tolerances, ±.008 and less, as well as high rolling speeds require horizontal and vertical roll stands (hence the name H/V) to be arranged in the finishing train. Only in this way can the material be finished without twisting and without tension, while using loops. Automatically operating loop lifters* between the stands keep the size of the loops within pre-set limits by varying the speed of the drive motor of the following stand through regulators. This entails individual drive for each roll stand and one-strand rolling in the finishing groups. Closer tolerances and increased production result from the use of high efficiency mechanical and electrical equipment. Three new SCHLOEMANN rolling mills of H/V layout are shown here. A report on two other mills will be published in the next issue. All five mills are in successful operation.

	Material in inches	Strands: roughing train	Strands: finishing train
1	5/16 to 5/8 ○, □, hex., oct.	2	2
	5/8 to 1 3/8 ○, □, hex., oct.	1	1
	3/4 to 4 x 3/16 ▭	1	1
	3/4 to 2 3/8 ∟	1	1
	3/4 to 1 1/2 ⊥	1	1
	1 1/4 to 2 [	1	1
	1 1/4 to 1 1/2 I	1	1
2	5/16 to 1/2 ○ concrete rounds	2	2
	5/16 to 5/8 ○ precision rounds, mild steel	2	2 x 1
	5/16 to 1/2 ○ precision rounds, high carbon	2	2 x 1
	1/2 to 1 1/2 ○ precision rounds, high carbon	1	1
	5/8 to 1 1/2 ○ precision rounds, mild steel	1	1
	5/16 to 1 1/2 □	1	1
	3/4 to 1 1/2 ∟	1	1
	3/4 to 1 1/2 ⊥	1	1
	3/4 to 1 1/4 x 3/16 ▭	2	2 x 1
	1 1/2 x 3/16 to 3 x 3/4 ▭	1	1
3	3/16 to 3/8 ○	4	4 x 1
	9/32 to 1/2 ○	4	2 x 2
	9/32 to 3/8 ○ deformed concrete rounds	4	2 x 2

* Leaflet D9e is available on this automatic SCHLOEMANN loop lifter which ensures closer tolerances.



FELLER ENGINEERING COMPANY, 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.

trols, fuses, protective and regulative circuitry.

The metallurgical laboratory houses facilities for investigating and analyzing fabrication welding and soldering of rare metals, while the measurements laboratory will use equipment for measuring electric currents ranging from microamperes to hundreds-of-thousands of amperes.

Supporting facilities include an electromechanical laboratory, used primarily for the development of mechanisms for d-c power circuit breakers, and a consulting engineering laboratory containing electric analog computers and power sources of several thousand watts at various frequencies.

In addition to doing research on semiconductor and power controlled rectifiers, Mr. Hansen said the new center will also develop circuitry and design equipment for mercury arc rectifiers.

Additional supporting facilities include life test and load test centers, and a circuits laboratory with power sources ranging from several thousand volts a-c or d-c and variable frequency power supplies.

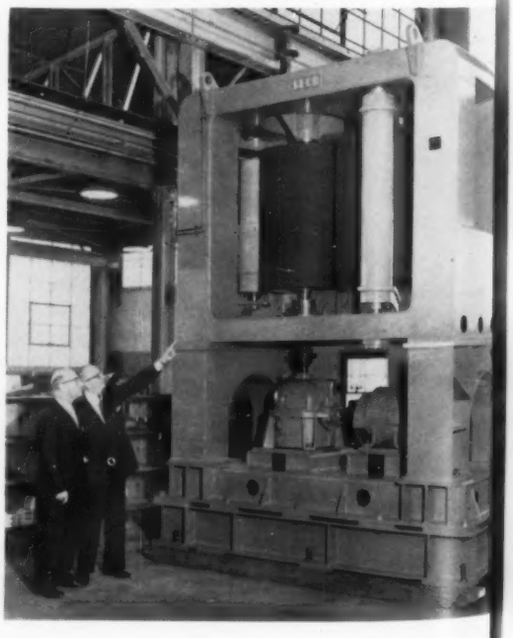
GERMAN FIRM PURCHASES PIPE MILL EQUIPMENT

△ Electric resistance weld pipe mill equipment, valued at more than $1,000,000, has been bought by Phoenix-Rheinrohr A. G. of Duesseldorf, West Germany, from the McKay Machine Co. for Phoenix-Rheinrohr's new pipe mill at its Muelheim plant.

This machinery will be used in the production of $6\frac{5}{8}$ in. to $16\frac{1}{2}$ in. OD API pipes. Delivery and instalment are scheduled for late this year.

NEW TENSION ROLL

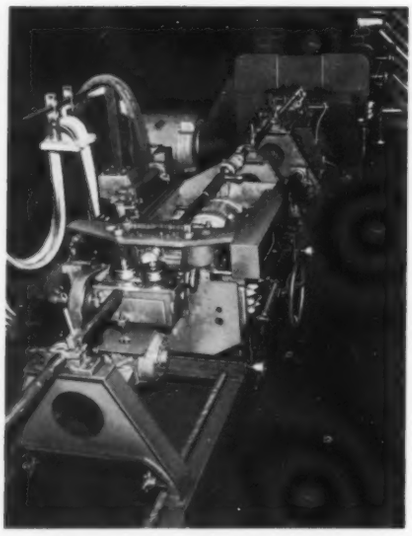
Lee Wilson, chairman of the board, Lee Wilson Engineering Co., Inc., and F. J. Keller, president of the Steel Equipment Co., inspect one of the first units of coiling equipment currently being manufactured for the Lee Wilson opened coil annealing system for U. S. Steel Corp.'s, Irvin Works. Lee Wilson Engineering Co. has purchased a substantial interest in Steel Equipment Co., which will make all coiling machinery for the new annealing system. Contracts have been placed for two pilot units. The one at Irvin Works is for annealing tinplate coils, and the other, for Dominion Foundries and Steel Ltd., for annealing heavier gage materials such as sheet coils for auto body stock.



LOMATIC

COMBINED DRAWING STRAIGHTENING CUTOFF AND POLISHING MACHINE

Payoff - Drawbench - Straightener



Flying Shear - Polisher - Discharge

Now available in two standard sizes, the revolutionary LOMATIC machines handle ferrous and non-ferrous rods and tubes at speeds up to 200 ft. per min. and with drawing capacities up to 16,000 lb. Compared to conventional separate rod drawing, straightening, polishing and cutting-to-length operations, the LOMA single-operation fully automatic machine offers the following major advantages:

- **Greater output rate — continuous operation at high speed**
- **Reduced labor cost — only one operator required**
- **Improved straightness — stock is straightened in two planes**
- **Perfect concentricity — obtained by straight-line drawing action**
- **Higher surface finish — due to two-stage polishing unit**

The complete line comprises an uncoiler, a pre-straightener, a drawbench, a roller straightener, a flying cutoff, a polishing machine and a discharge table. All components required for the complete sequence of processing operations are interlocked mechanically and electrically into one integrated and synchronized line which is controlled by only one operator.

Our standard line of equipment includes:

- **Casting Machines and Molds**
- **Saws and Cut-off Machinery**
- **Hot and Cold Rolling Mills**
- **Rod and Tube Draw Benches**
- **Roller and Stretcher Levellers**
- **Air and Hydraulic Tube Testers**

LOMA
MACHINE MFG. CO., INC.
114 East 32nd Street
New York 16, N. Y.

A-B QUALITY

ALLEN-BRADLEY
Solenoid Starters give

MORE MILLIONS OF TROUBLE FREE OPERATIONS

. . . and for good reasons

• ONE MOVING PART
With this simple solenoid design, there's virtually nothing to go wrong—all trouble-causing bearings, pivots, and flexible jumpers have been eliminated.

• DOUBLE BREAK, SILVER ALLOY CONTACTS
Allen-Bradley silver alloy contacts never require maintenance. They are always in perfect operating condition . . . and remain so until completely worn away.

• SIMPLE UP-AND-DOWN MOTION
The virtually frictionless, straight line vertical motion provides uniform contact pressure at all times—and assures consistent, rapid operation of the contactor.

• RELIABLE OVERLOAD PROTECTION
All A-B starters are equipped with two permanently accurate and reliable overload relays that protect motors against "burnouts." Three overload relays can be furnished.

BULLETIN 709 STARTERS are made in 9 sizes from Size 0 (at left) up to Size 8.

BULLETIN 709 SIZE 7 with maximum ratings of 300 hp, 220 v; 600 hp, 440-550 v.

ALLEN-BRADLEY

Allen-Bradley Co., 1343 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY MOTOR CONTROL

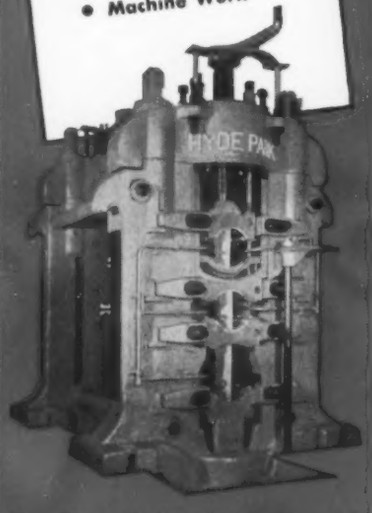
RED CIRCLE Rolls ALLOY-CHILLED

Hyde Park

Rolling Mill Equipment

For more than 50 years Hyde Park Steel Mill equipment has been helping American industry lead the world — equipment such as—

- Bar Mills
- Merchant Mills
- Sheet and Strip Mills
- Pinion Stands
- Roller Tables
- Reduction Drives
- Stretcher Levellers
- Guillotine Shears
- Sheet Mill Shears
- Roll Lathes
- Special Machinery
- Machine Work



For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park

FOUNDRY & MACHINE CO.

Hyde Park, Westmoreland Co., Pa.

ROLLS

ROLLING MILL MACHINERY

GRAY IRON CASTINGS

NEW STEEL PLANT TO BE BUILT IN CANADA

△ The construction of Western Canada's first iron and steel smelter will be started immediately at Kimberley, B. C., by the Consolidated Mining and Smelting Company of Canada Ltd. The smelter will be the first stage in an integrated iron and steel operation costing in excess of $20,000,000 which will produce pig iron, steel ingots and rolled steel products to serve the rapidly growing markets in western Canada.

The smelter will be located adjacent to Comincos chemical fertilizer plants in Kimberley and will employ over 200 men. The first stage will consist of sintering and furnace feed facilities for a capacity of 100,000 tons of steel per year and one electric furnace with design capacity of 36,500 tons of pig iron per year, with production of these units scheduled for early in 1961. The addition of a second larger furnace and oxygen-blown converters for the production of steel ingots together with fabricating facilities will follow in the very near future, according to company plans.

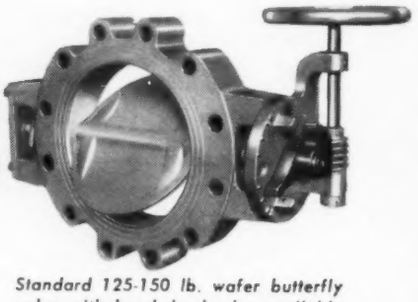
Large reserves of iron tailings from the Sullivan mine at Kimberley have long been recognized as a major source of raw material for a primary iron smelter in western Canada. Reserves equivalent to over 15,000,000 tons of recoverable iron have accumulated during the years and current mine production increases these reserves by the equivalent of over 350,000 tons of iron each year. This raw material will be made available to the new project in the form of a high grade iron oxide containing over 60 per cent iron. These iron reserves, Comincos hydro-electric power resources on the Kootenay and Pend Doreille Rivers, and the proximity of coal, coke and limestone in the Crows Nest Pass area, constitute a unique combination of the materials needed for the electrothermic production of iron and steel.

Meetings

△ The American Welding Society fall meeting will be held in the Sheraton-Cadillac Hotel, Detroit, Mich., September 28–October 1.

ROCKWELL

"WAFER" VALVES



■ LOWER IN FIRST COST

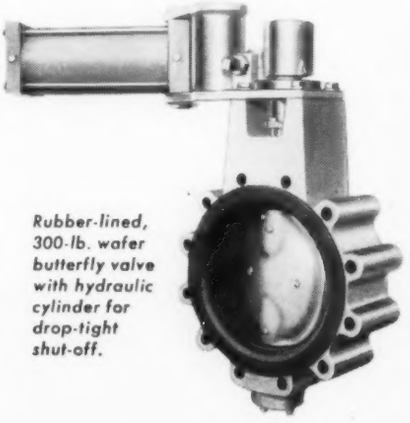
■ NEED MINIMUM SPACE

■ EASY TO OPERATE

Standard 125-150 lb. wafer butterfly valve with handwheel; also available with lever control or mechanical operators.

For controlled throttling or tight shut-off of air, gases, process fluids or semi-solids, Rockwell Wafer Butterfly Valves offer the advantages of rugged construction, compactness, small face-to-face dimension to fit in minimum clearance between pipe flanges.

Write for Bulletin 580.



Rubber-lined, 300-lb. wafer butterfly valve with hydraulic cylinder for drop-tight shut-off.

ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL COMPANY

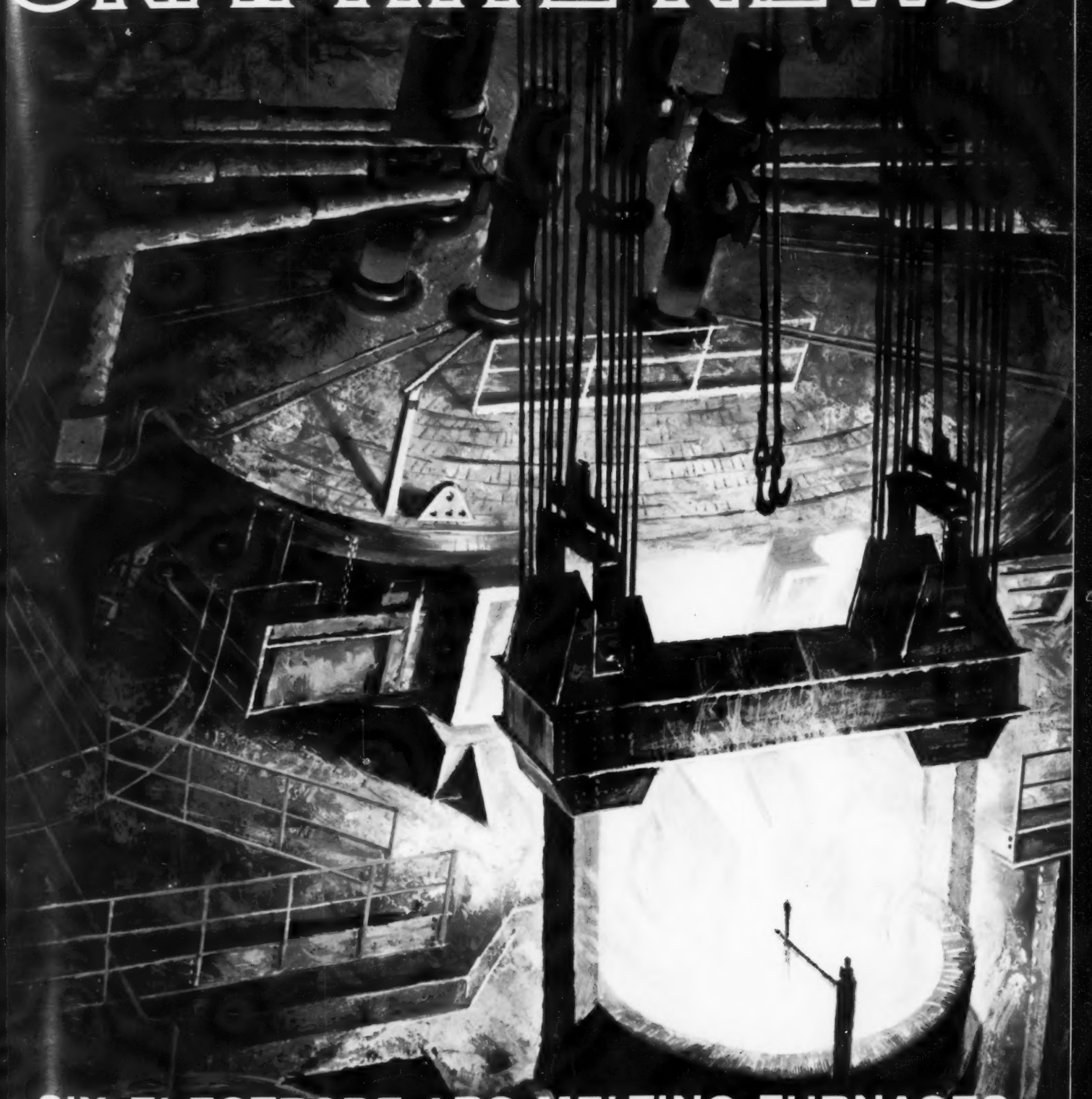
Valves—Butterfly · Slide · Diaphragm · Special

2429 ELIOT STREET • FAIRFIELD, CONN.

MAY 1959

NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS



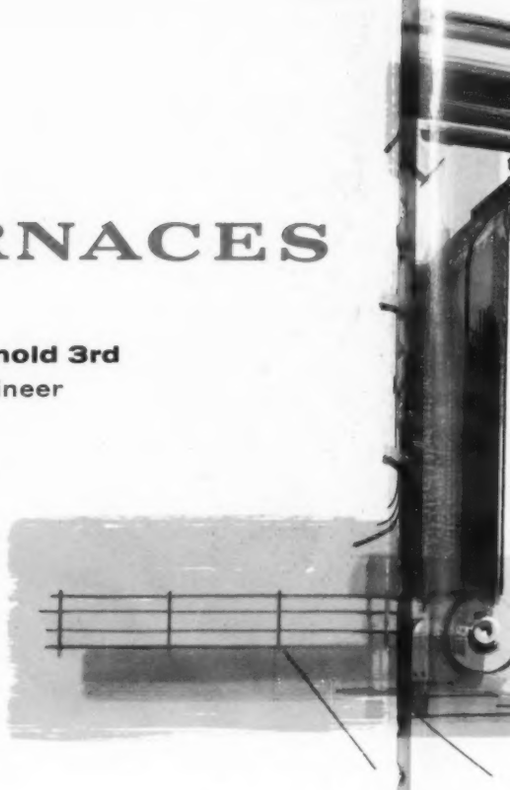
SIX-ELECTRODE ARC MELTING FURNACES

By Samuel Arnold 3rd
Consulting Engineer

SIX-ELECTRODE ARC MELTING FURNACES

By Samuel Arnold 3rd
Consulting Engineer

Samuel Arnold 3rd graduated from Pennsylvania State University in 1913 with a B.S. Degree. In 1918, he received an E.E. Degree from the same University. From 1916 to the present, he has been primarily concerned with the development, sale and use of Heroult electric arc furnaces. In 1927, he developed the use of multiple voltages as applied to arc furnaces. In 1928, he was responsible for the design of the first successful six-electrode steel melting furnace. Since 1925, Mr. Arnold has been Consulting Engineer for American Bridge Division of United States Steel Corporation.



INTRODUCTION

To keep pace with the demand for electric furnace steel, electric furnaces have continued to increase in size and use of power. In 1906, the first heat of electric furnace steel was made in the United States. The furnace used for this heat was built in France by Dr. Heroult and consisted of a rectangular shell with two electrodes for single phase operation. Shortly thereafter three phase power was utilized and the logical design was a cylindrical shell. These early furnace designs had a relatively shallow bath and were equipped with transformers of low capacity.

During the years that have followed, the development of arc furnaces has primarily consisted in increasing the shell diameters and height to give deeper hearth capacity as well as greater volume. At the same time, considerably increased transformer capacities have been furnished, together with controls of greater sensitivity. At present, the largest three-electrode cylindrical furnace has a shell diameter of 24′-6″, and power loads slightly in excess of 35000 KVA have been used. The 24′-6″ furnace has made heats greater than 200 tons, but perhaps the best

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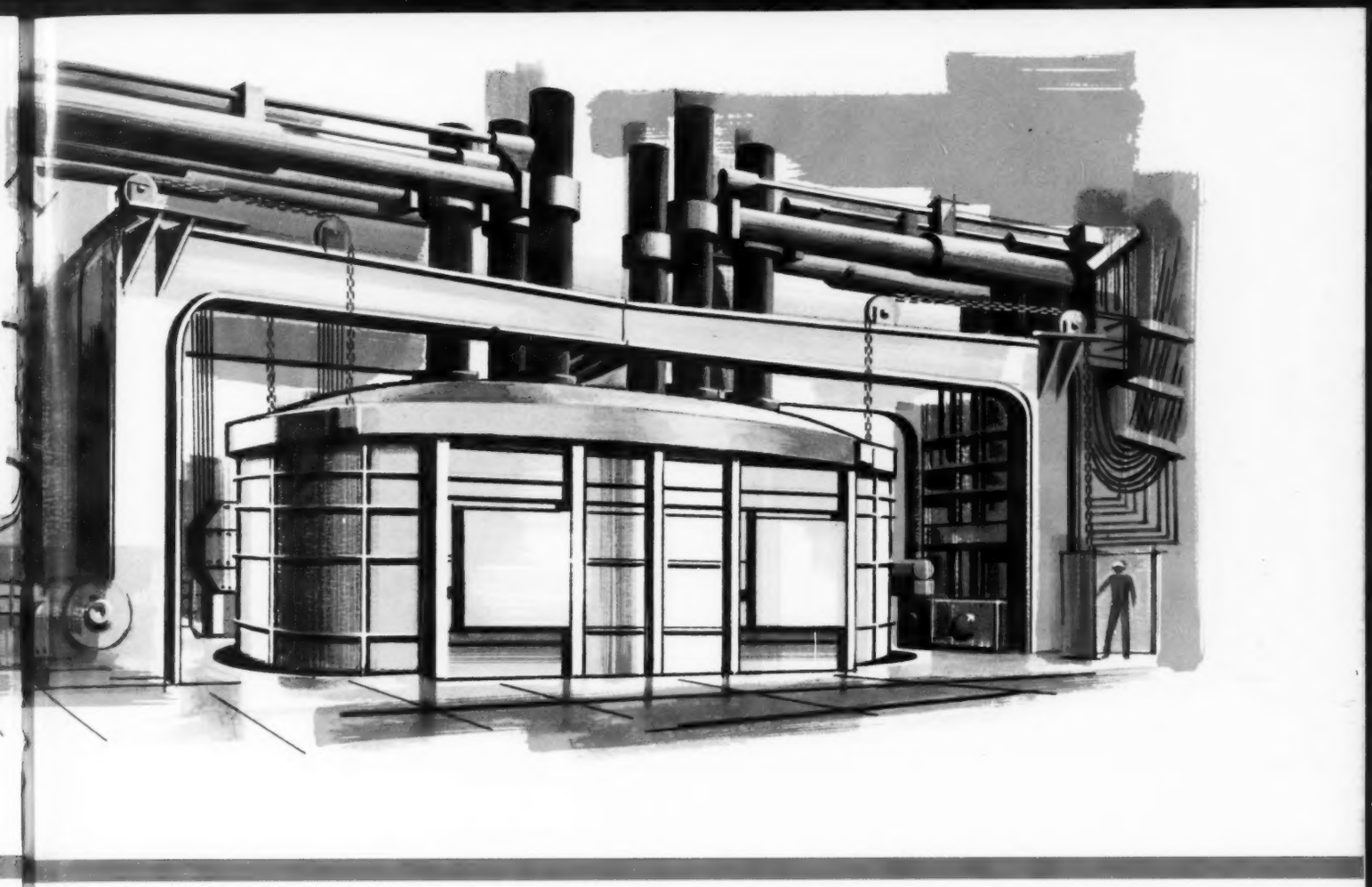


operating capacity is approximately 180 tons. Without question, larger furnaces can and will be built in the future, and it is important to consider the most effective design.

For many years, the primary function of arc furnaces has been the melting and refining of special high grade carbon and alloy steels. However, in the last fifteen years, the use of arc furnaces has been extended to the manufacture of ordinary carbon steels, and in that field they are competing favorably with open-hearths. The reason that arc furnaces can compete so favorably has been primarily due to the wide use of the removable roof for quick charging, and the use of larger transformers and better regulation. Since the Second World War, light scrap has been used in arc furnaces almost exclusively, and as the use of this light scrap gives greater area to absorb radiant energy, higher power, when properly applied, can speed the melt.

In the melting down process, high power applied to modern three-electrode furnaces is now used only until a bath has been partially formed. As a result, the use of high power is limited as to time, and, therefore, full use of the transformer cannot be obtained. This in turn decreases the load factor and increases the time to melt and production cost. How then can we obtain a better utilization of the power available in these proposed larger furnaces?

With three electrodes, there are three concentrated areas for the release of energy, and as long as the scrap area is maintained, this high energy can be absorbed. However, once the bath has been formed, superheating can occur in the energy liberating areas. This increases the energy radiated to the refractories. Unless the power load is diminished to correspond to the rate of heat absorption in the charge, refractory deterioration rapidly occurs. The logical answer to this problem as larger furnaces are built, is to provide more energy releasing areas for the same amount of power used, thus taking advantage of power availability to provide an efficient quick melt with a minimum of refractory deterioration. A multiple electrode furnace is, therefore, to be considered.

BIRTH OF SIX-ELECTRODE FURNACE

Thirty-one years ago the writer, riding by train from Pittsburgh to Canton, made a sketch of a six-electrode elliptical furnace and submitted the idea to the engineers of the Timken Roller Bearing Company. This preliminary design was slightly modified as to size, and a short time later the original elliptical shell six-electrode furnace was built by American Bridge and installed at the Timken Plant. I believe that this has been the only successful six-electrode steel melting furnace ever used. The shell of elliptical shape has an inside long dimension of 29 ft. and a width of 20 ft. The hearth is relatively shallow, and it is arranged for charging through two doors by means of a charging machine of the open-hearth type. The unit is equipped with two 7500 KVA transformers.

In 1953, Mr. James K. Preston, of the Timken Roller Bearing Company, presented a paper at the Annual Electric Furnace Committee meeting of the A. I. M. E. His paper was entitled "Comparative Melting Rates of an Elliptical Six-electrode Furnace and a Circular Three-electrode Furnace." Mr. Preston's conclusions definitely indicated that melting time and bath oxidation were more rapid in the old elliptical unit than in a modern three-electrode furnace, and stated in his conclusions that "the reason for this appears to be a result of the better distribution of the radiant energy from the arcs."

The question now arises as to why this prototype six-electrode furnace has not been further developed and utilized. The probable answer to this question is the fact that with the use of the removable roof and higher transformer capacities, together with the availability of light scrap, the three-electrode furnace has been developed to the present capacities as a relatively efficient unit.

With a 24 ft. diameter shell three-electrode furnace and 35000 KVA transformer capacity, 24" electrodes are necessary. To provide movement for these electrodes, motors of 25 H. P. have been used. To control these motors, requires a motor generator set with driving motor capacity approximating 75 H. P. per electrode. If larger three-electrode furnaces are built with as much as 50000 KVA transformer capacity, still larger electrode sizes will be required. This in turn would require heavier electrode arms, with motor sizes necessarily increased.

To introduce 40000 KW from a 50000 KVA power transformer at an acceptable power factor would require relatively high secondary voltages. This increased voltage would in turn increase the length and configuration of the arcs. Problems of carrying the heavy current to the furnace would also be multiplied.

In the November issue of Carbon & Graphite News, one of the problems of utilizing power in electric furnaces has been ably outlined by Mr. W. E. Schwabe. The problem discussed by Mr. Schwabe relates to the introduction of equal amounts of energy at each electrode tip. Because of the inherent design of the bus and cable structure, the variation in impedance in the phases results in a variation of the amount of energy liberated at each arc. The unbalancing effect and its correction will be greatly magnified as current values are increased.

ADVANTAGES OF SIX-ELECTRODE FURNACE

If increased furnace holding capacities are to be used in the future, serious consideration should be given to the six-electrode unit. The advantages to be had from a six-electrode furnace as compared with a three-electrode furnace are as follows:

1. Six energy liberating areas would be had instead of three to better utilize the power available.
2. Lower secondary voltages and lower current values can be used, thus minimizing the problem of carrying the power to the furnace and liberating the energy uniformly.

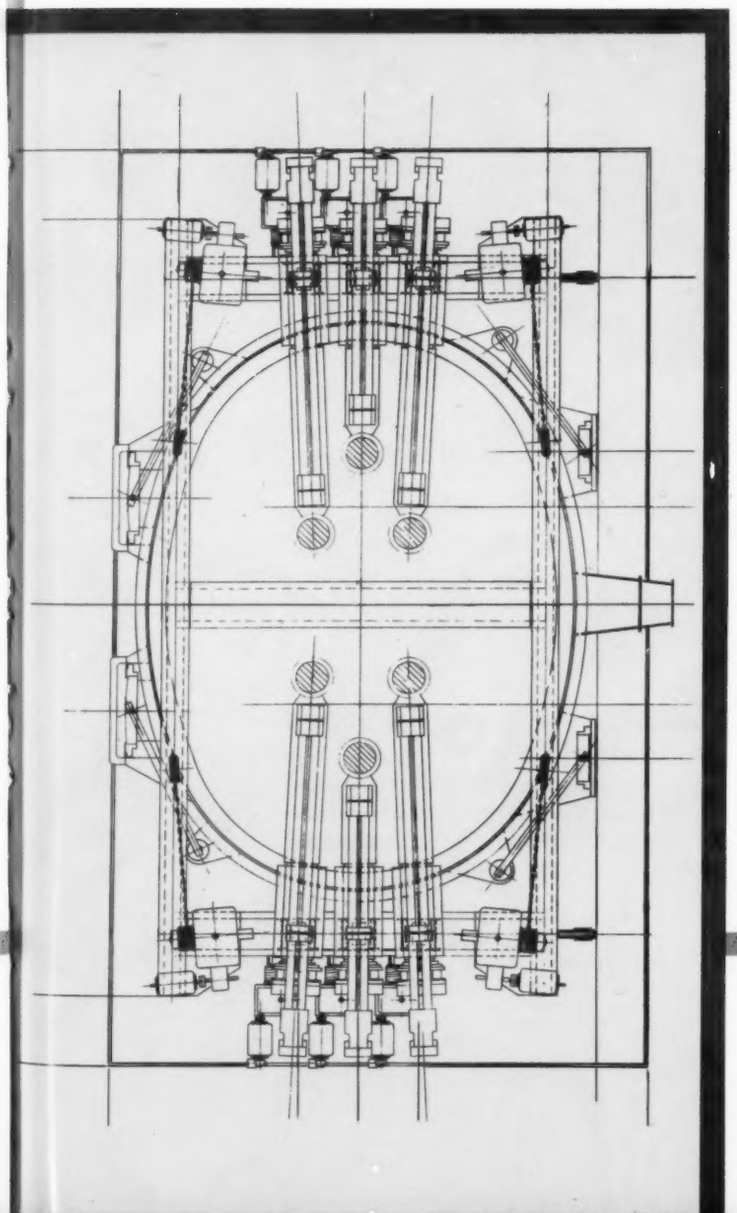
3. A six-electrode furnace with an elliptical shell will offer less difficulty of bottom and side wall maintenance. This is primarily due to the fact that the lateral spacing between front and back wall would be less than on an equivalent holding capacity three-electrode unit. Refractory losses would also be materially reduced, due to the fact that less heat will be radiated to the refractories from the bath, with a greater amount of the liberated energy absorbed by the charge. With increased refractory life, furnace down time will be less.
4. With smaller electrodes, as well as electrode holders and masts of less weight, electrode motor sizes are materially reduced. Therefore, more accurate electrode regulation can be obtained. Futhermore, the handling and servicing of smaller electrodes minimizes cost.

A BASIS FOR COMPARISON

As a means of comparing a large six-electrode furnace with a present day large three-electrode furnace, a preliminary design of a 250 ton holding capacity, six-electrode unit has been made. The shell of this furnace would be an ellipse with a dimension of approximately 35 ft. in length and 24 ft. in width. It would be equipped with two 25000 KVA transformers and would use two sets of three 20″ electrodes arranged in a similar way to the original six-electrode furnace (see cover illustration). The side frames would be connected together to form a gantry designed to carry the roof. The roof would be lifted and the gantry and roof moved out over the tapping side to permit charging. If two six-electrode furnaces were installed, a central transformer vault would house two of the transformers, with all of the switching equipment at the central location. On each opposite side, there would be a smaller transformer vault to house the additional transformers, panel and regulator.

Calculated data pertaining to a 250 ton holding capacity 35′0″ x 24′0″ six-electrode furnace equipped with two 25000 KVA transformers and using 20″ electrodes, is as follows:

1. Furnace to be initially charged with 125 tons of scrap and a 125 ton re-charge made.
2. 50000 KVA at 80% power factor, 40000 KW demand.
3. At 85% power-use factor* for melt, 34000 KW average power load.
4. Assume 400 KWH per ton required to melt scrap only.
5. 125 tons at 400 KWH per ton, 50000 KWH required to melt initial charge.
6. At 34000 KW average load, time required to melt initial charge, approximately 1 hour 28 minutes.



ESTIMATED HEAT CYCLE

(35′ 0″ x 24′ 0″ Six-Electrode Furnace, Ordinary Carbon Steels)

Fettle bottom		25 min.
First charge, 2 buckets, 62½ tons each		30 min.
Melt first charge	1 hr.	28 min.
Re-charge, 2 buckets, 62½ tons each		30 min.
Melt re-charge	1 hr.	28 min.
Refine & bring to temperature	1 hr.	0 min.
Tap		20 min.
TOTAL TIME	5 hrs.	41 min.

6 hour heats, or 4 heats per 24 hours for ordinary carbon steels

*The term power-use factor refers to the average amount of power that is normally used at a given power demand.

It is to be noted that an 85% power-use factor has been utilized in calculating the average KW power load during the melting period. It is highly probable that this power-use factor would be increased due to the relatively low amount of energy to be released at each electrode tip, and its more rapid absorption by the charge. Any increase in power-use factor would reduce the time of melt. The time required for bringing the bath to temperature and refining for ordinary carbon steels might also be reduced, and it is probable that more than 4 heats can be obtained in 24 hours.

In the above calculations, the use of oxygen has not been considered. If oxygen is used, the heat time will be materially reduced. On this basis, it is possible to produce 5 to 6 heats per 24 hours.

ESTIMATED ANNUAL PRODUCTION RATES

(Six-electrode 250 ton furnaces and three-electrode 180 ton furnaces)

Furnace availability 95% for average of 684 hours per month.

SIX-ELECTRODE FURNACE—50000 KVA

6 hour heats—250 tons per heat
41.6 tons per hour (conservatively estimated)
28,454 tons per month—341,448 tons per year per furnace

THREE-ELECTRODE FURNACE—35000 KVA

27.5 tons per hour (obtained with existing furnaces)
18,810 tons per month—225,720 tons per year per furnace

Two six-electrode 50000 KVA furnaces—approximately 680,000 tons per year
Three three-electrode 35000 KVA furnaces—approximately 675,000 tons per year

The production figures as outlined are for **comparative purposes only.** With modern transformers equipped with heat exchangers, overloads can be carried and together with the use of oxygen, average production in excess of 27.5 tons per hour of ordinary carbon steels can be obtained from the three-electrode 35000 KVA furnaces. This possibility of increased production holds true to an even greater extent when the six-electrode furnace is considered, for the reason that the increased power can be more readily utilized. With the use of oxygen and utilization of increased power, production in excess of 50 tons per hour can no doubt be obtained with the six-electrode furnace. It is possible with very light scrap that more than one re-charge may be necessary. This would apply to either the six-electrode or three-electrode furnace.

In the foregoing comparison of large six-electrode with large three-electrode furnaces, no consideration has been given to the use of high intensity gas burners to facilitate melting, nor has consideration been given to the use of hot metal. Based on existing practice, there is no question but that hot metal can be utilized as a part of the charge, perhaps as much as 50% of the charge. In the use of hot metal, the six-electrode furnace will have the advantage of better distribution of the energy without superheating portions of the bath.

COMPARISON OF POWER DEMAND

Three (3) 24'0", 35000 KVA three-electrode furnaces, two melting at 35000 KVA each, and one refining at 10000 KVA, with diversity factor of 85%, 68000 KVA demand.

Two (2) 35'0" x 24'0", 50000 KVA six-electrode furnaces, one melting at 50000 KVA, one refining at 15000 KVA, with diversity factor of 85%, 55250 KVA demand.

It may be said in connection with the two six-electrode 50000 KVA furnaces that a period could occur when both units would be melting. This same probability of melting times coinciding could also occur with three three-electrode 35000 KVA furnaces. In either case, the best operating pre-determined maximum demand would of necessity be utilized. This does not alter the fact, however, of an indicated lower power demand for the two six-electrode furnaces.

Comparison of Kilowatts of available and usable power per ton of charge during melt down

24'0" Furnace, 180 ton total heat, 90 ton charge

35000 KVA, 80% power factor, 28000 KW
90 ton initial charge, energy introduced per ton of charge, 310 KW
Energy introduced per ton of charge per electrode, 103.3 KW

35'0" x 24'0" Furnace, 250 ton total heat, 125 ton charge

50000 KVA, 80% power factor, 40000 KW
125 ton initial charge, energy introduced per ton of charge, 320 KW
Energy introduced per ton of charge per electrode, 53.3 KW

As the energy to be liberated per electrode per ton of charge for the 50000 KVA six-electrode furnace is but slightly more than half of the energy which must be liberated per electrode per ton of charge for the 35000 KVA three-electrode furnace, it follows that the rate at which energy is to be absorbed by the charge at each electrode tip is also but slightly more than half. As this lesser amount of energy per electrode is more readily and more rapidly absorbed, it means that the full advantage of the existing available power can be obtained. This in turn increases furnace melting efficiency, decreases refractory deterioration and decreases the time required to melt.

COST COMPARISON

(2 six-electrode 50000 KVA furnaces with 3 three-electrode 35000 KVA furnaces)

Capital Costs

As to initial expense, it is estimated that two 50000 KVA six-electrode furnaces installed would not be far different in cost than if three 35000 KVA three-electrode furnaces were used. In connection with the shop, however, while the length of the building might be slightly reduced, larger ladle cranes would be required for the two six-electrode units as compared with the three three-electrode furnaces. These larger ladle cranes would, of course, entail a somewhat heavier building and slightly greater cost.

Operating Costs

Refractories: As previously mentioned, refractory costs for six-electrode furnaces should be materially less than for three-electrode units. This is primarily due to the better absorption of the energy by the scrap and lesser amounts of radiant heat reflected to the side walls and roof. Decreased refractory cost of 12% to 15% could, no doubt, be obtained.

Electrodes: Electrode consumption and electrode cost per ton of steel produced in two six-electrode furnaces will be approximately the same as that obtained with three three-electrode units.

Power: Because of the lower power demand required for two six-electrode furnaces, the cost per unit of power will probably be decreased over that which could be obtained in operating three three-electrode furnaces. This decrease may be 3% to 5% of the power cost.

Labor: Two six-electrode furnaces will require two crews per turn, and three three-electrode furnaces will require three crews per turn. Assuming direct furnace labor at 50% of the total furnace shop labor, there is indicated a saving of 16⅔% in labor cost.

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Overall Costs

In combining amortization of capital cost with operating expense based on lower refractory cost, lower power cost, lower labor cost and equal electrode cost for the six-electrode furnaces, it is definitely indicated that two 50000 KVA six-electrode furnaces would show lower overall operating costs than three 35000 KVA three-electrode furnaces. It is entirely probable that this lower operating cost of the six-electrode furnaces could range up to $2.00 per ton of steel produced. On the basis, however, of only $1.00 per ton lower cost, there is indicated a saving of $680,000.00 per year on a yearly production of 680,000 tons. It is possible that a higher power-use factor than that previously outlined can be obtained with a six-electrode furnace. Oxygen can also be utilized. In both cases production would be increased and with increased production, greater savings would accrue.

FUTURE DESIGN OF ELECTRIC FURNACES

The six-electrode furnace that has been outlined as a 50000 KVA unit would have a nominal holding capacity of 250 tons and would use 20″ electrodes. Without modifying to any great extent the design of the present electrode system and use of power as now applied to existing three-electrode furnaces, a 300 ton 70000 KVA six-electrode furnace using 24″ electrodes could be built. It would also be possible to build a 50000 KVA approximately 250 ton holding capacity, three-electrode furnace using 30″ electrodes. In building these larger three-electrode furnaces, however, problems would be magnified relating to mechanical and electrical design, minimizing refractory losses, full utilization of power and operating difficulties. It is, therefore, definitely indicated that higher melting efficiencies and lower operating costs would be obtained with six-electrode furnaces.

CONCLUSIONS

Based on the progress of the past, there is no doubt that the production of electric furnace steel will increase at an ever expanding rate. To provide for this expansion and to produce electric furnace steel at reasonable cost, furnaces of greater capacity will be built. As higher efficiencies and resultant lower operating costs can undoubtedly be obtained with the use of large six-electrode furnaces as compared with the use of large three-electrode furnaces, the future development and use of the six-electrode furnace is to be expected.

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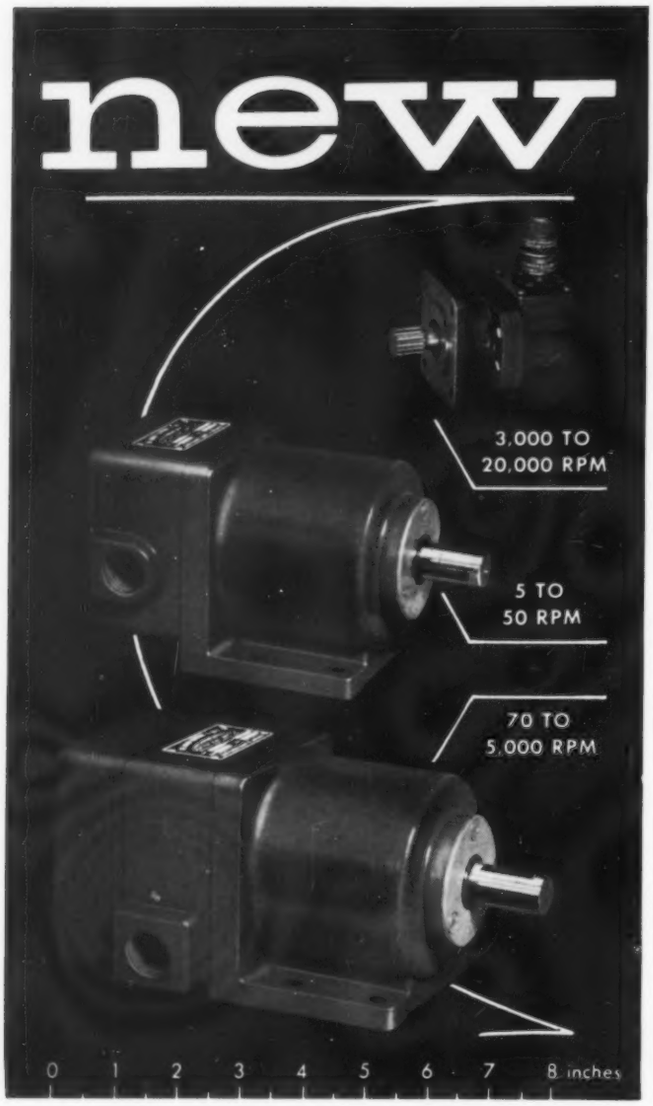

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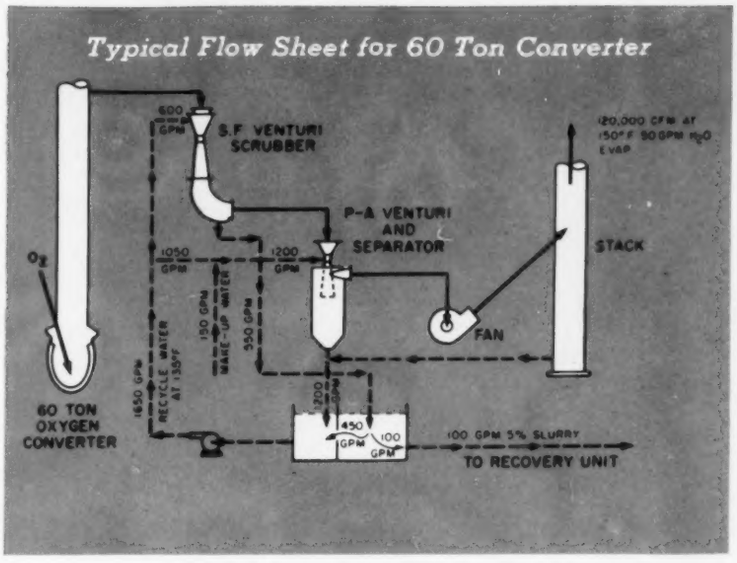

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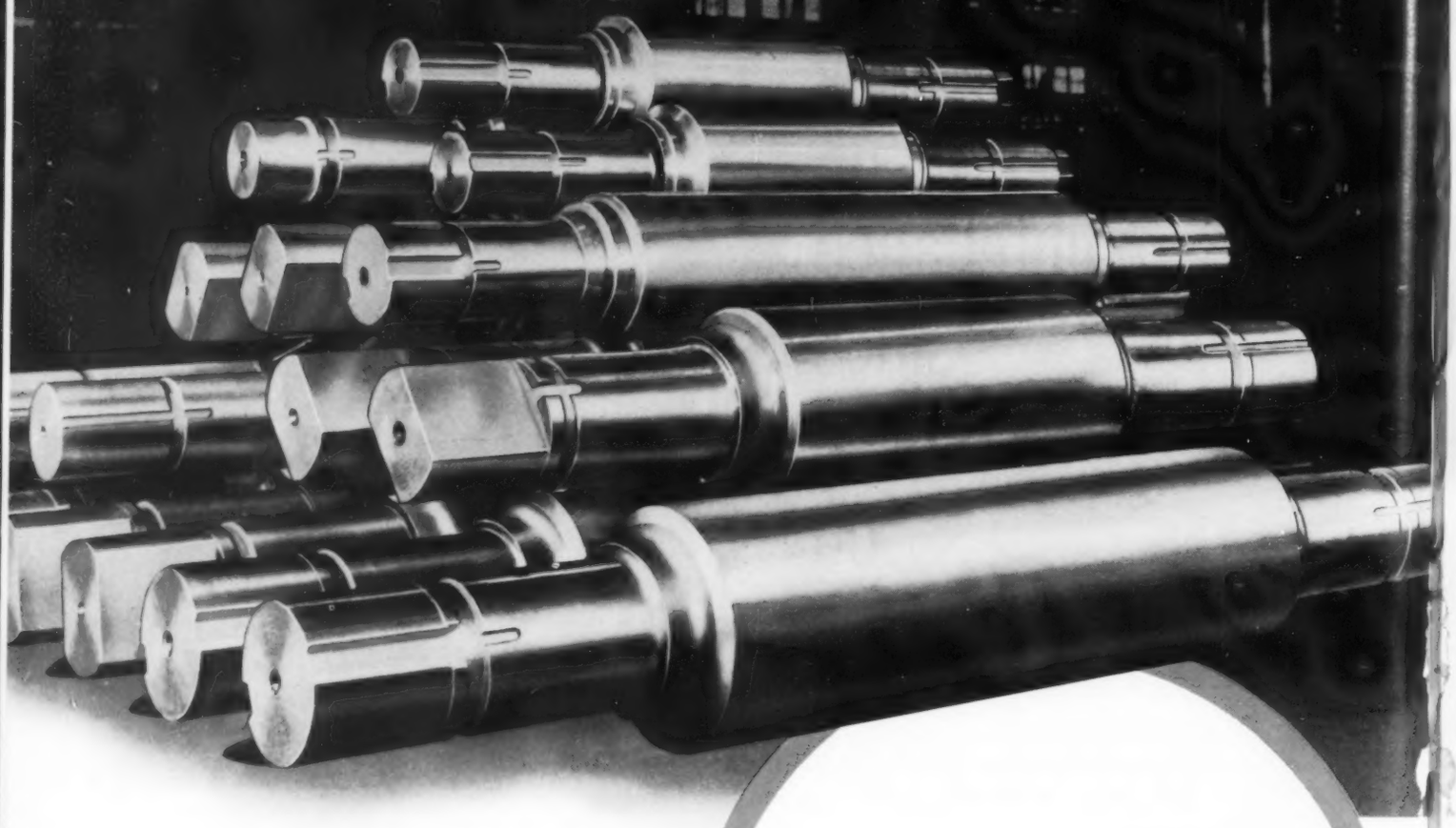

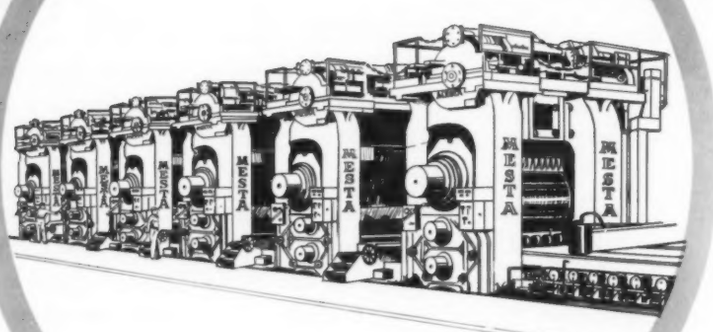

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Personnel News...

Arthur A. Kappenhagen has been appointed to the newly created position of general superintendent at Republic Steel Corp.'s Chicago, Ill., plant. Mr. Kappenhagen has been division superintendent—steel plant of Republic's Youngstown, Ohio, district since 1957. He joined Republic in 1935 as a turn foreman in the Labor Department at Republic's Cleveland, Ohio, plant. He later served as dock foreman, assistant labor superintendent and assistant superintendent of the open hearth department at the Cleveland plant. In 1953 he was transferred to the Youngstown plant as superintendent of the Open Hearth Department.

Harold R. Miller has been named superintendent of maintenance at the Butler, Pa., Works of Armco Steel Corp. He succeeds **Joseph Freeman,** who has retired after almost 48 years of service with the company. Mr. Miller joined Armco at the Butler Works in 1933, in the electric repair shop. In 1935, he was transferred to the hot and cold mill maintenance department and in 1946 became assistant foreman of that department. He was promoted to general foreman of assigned maintenance in 1951, and was named assistant superintendent of the maintenance department in 1958.

J. R. Philips, Jr., has been appointed to the newly created position of general superintendent at Republic Steel Corp.'s Youngstown, Ohio, plant. For the past 10 years, he was manager of the plant's order and shipping department. Replacing him in that capacity will be **E. M. Bulla,** assistant manager of the order department since 1951. **E. R. Ramsey** will take over Mr. Bulla's former duties. Mr. Philips joined Republic in 1937 as a schedule and service clerk in Gadsden, Ala. He was made assistant manager of the order department there in 1943 and was promoted to manager in 1945. He moved to Youngstown in 1949 as manager of the order and shipping department. Mr. Bulla started with Republic in 1936 as a pipe loader in the shipping department at the Youngstown plant. He became a steel order clerk in 1943, an open hearth scheduler in 1949 and assistant manager of orders two years later.

Leon J. Gang was named assistant chief industrial engineer for Republic Steel Corp. Mr. Gang has been associated with Republic and one of its predecessor companies since 1928 and has been supervisor of statistical standards in the Industrial Engineering Department in the company's Cleveland offices since 1949. He started as industrial engineer in Republic's Central Alloy District and since has been employed as staff industrial engineer in the company's general offices.

Floyd W. Schmidt has been appointed superintendent and **Clinton S. Banks,** assistant superintendent in the Construction Department of Weirton Steel Co., division of National Steel Corp. Mr. Schmidt, who had served as assistant construction superintendent since joining Weirton in 1955, succeeds **W. P. Linn** who retired March 31 after 38 years of service with the company.

Mr. Banks joined Weirton in 1925 as a field engineer and prior to his current appointment was supervising construction engineer in the Construction Department.

Frank E. Walling has been appointed general superintendent of the Claymont, Del., plant of Colorado Fuel & Iron Corp. Prior to this appointment, Mr. Walling was product engineer at the Claymont plant. At the same time, **Ernest C. G. Soffronoff** was appointed superintendent of maintenance at Claymont.

Edward K. Barney has been appointed assistant to the general superintendent, Baltimore Works of Armco Steel Corp. Mr. Barney has been with Armco since 1938.

J. Paul Games has been named superintendent of industrial relations for Midwest Steel Corp., the new plant which National Steel Corporation will build in Indiana. Mr. Games has assumed his new duties and is working both at Weirton Steel and at Midwest's temporary offices in Valparaiso, Ind. Prior to joining Midwest Steel, Mr. Games had been an employee of United States Steel Corp. for 19 years, having joined that firm in 1940 as an industrial engineer in the Vandergrift, Pa., plant. He was promoted to plant industrial engineer in 1945 and to assistant to the plant superintendent in 1948. A year later he was named superintendent of industrial relations at the Vandergrift plant and in 1950 was promoted to assistant superintendent of industrial

A. A. KAPPENHAGEN

H. R. MILLER

J. R. PHILIPS JR.

L. J. GANG

A. B. GLOSSBRENNER

H. I. MARTIN

W. H. JACKSON

E. W. MOFFITT

relations of the larger Irvin Works, holding that position until his present appointment.

Alfred B. Glossbrenner has been named superintendent of the Conditioning Department of The Timken Roller Bearing Co.'s Steel and Tube Division. Mr. Glossbrenner first worked for Timken in 1949 as a foreman trainee in the Material Handling Department. He was made foreman in that department in 1950 and was named assistant general foreman of the Bloom Conditioning Department in 1953. He was promoted to general foreman of that department in 1957, the position he held at the time of this promotion.

Harold I. Martin was named president of Swindell-Dressler Corp. He succeeds **William H. Cosgrove** who will become chairman of the board and remain as chief executive officer. **Samuel B. Casey, Sr.,** formerly board chairman, is now chairman of the finance committee. Other officer changes announced are **Philip Dressler,** executive vice president; **Hugh J. Pugsley,** senior vice president; **Gerome Gordon** and **Owen H. Cross,** vice presidents. Mr. Martin joined Swindell-Dressler in 1941 and had been in charge of design and construction of engineering projects.

Mr. Gordon and Mr. Cross, together with **Robert M. Morris,** already a vice president, were elected to the board of directors.

William H. Jackson has been elected vice president in charge of sales of the Diamond Power Specialty Corp. Mr. Jackson was formerly assistant marketing manager of The Babcock & Wilcox Co.'s Boiler division. He joined Babcock & Wilcox in 1936 as a student engineer at the company's Barberton, Ohio, Works, and from 1937 to 1946 was employed as an analytical combustion engineer, a field supervisor of analytical test groups, a service engineer and a member of the proposition and contract department. In 1946, Mr. Jackson was appointed a representative in B&W's Philadelphia district sales office, and in 1957 was promoted to assistant sales manager of the Boiler division. When Babcock & Wilcox consolidated division operations in Barberton last year, he was appointed assistant marketing manager for all industrial products.

Edward W. Moffitt has been appointed general manager of Midvale-Heppenstall Co. In his new position Mr. Moffitt will be in charge of all plant production operations of the company. He was formerly general manager of the Bridgeport, Conn., plant of Heppenstall Co.

Lee J. Gillett, formerly procurement manager for Kaiser Engineers, has been appointed director of purchases. In his new position Mr. Gillett assumes management of all purchasing, expediting and traffic activities in connection with the company's engineering and construction projects. He takes over this position from **J. H. Rowan,** who has assumed a consulting position as director of special purchases for the firm.

M. Earl Saxman has been named plant manager of the Chicago district plant at Lansing, Ill., of Vulcan Mold & Iron Co. At the same time **Arthur Moynihan** was named Lansing foundry superintendent. Mr. Saxman advances to his new post from foundry superintendent; having earlier been turn superintendent at the company's Latrobe, Pa., plant. Mr. Moynihan advances from a production foreman at Lansing. Previously he was a production foreman at Inland Steel Co. for 11 years, and a junior metallurgist at Wisconsin Steel Works.

Harry G. Smith, formerly with Auburn & Associates, Inc., has joined J. G. Kassab, Inc., as chief engineer.

Fred A. Meunier has recently joined Magnaflux Corp. as senior engineer in the Electronic Engineering Department. For 19 years, Mr. Meunier has been with Republic Steel Corp. as production engineer, electrical engineer and, most recently, project engineer in the Electro-Mechanical Research Center.

W. O. Owen has joined Natural Gas Equipment Inc., representatives of Surface Combustion Corp. in California and other Western States. Mr. Owen will augment the staff of Natural Gas Equipment in handling both standard and special production furnaces and gas generators manufactured by Surface Combustion Corp.

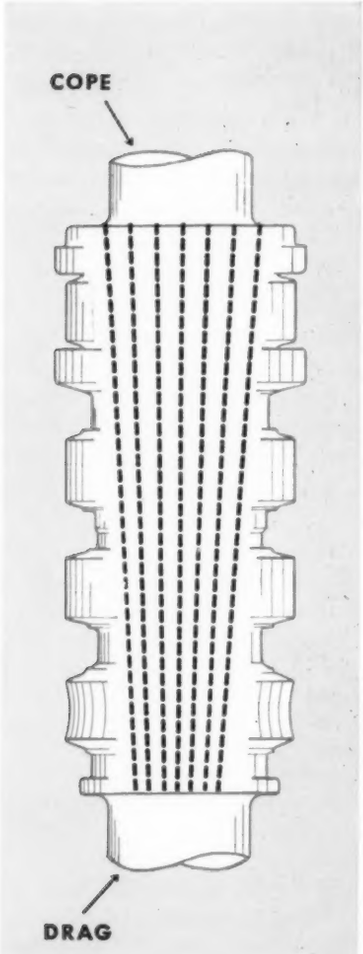
Charles D. Preusch has been appointed materials and process engineer by the Crucible Steel Co. of America. Formerly chief metallurgist at the company's Spaulding works in Harrison, N. J., he will now be responsible for providing company-wide standards of materials, practices and measurements in steelmaking primary operations. Mr. Preusch joined Crucible in 1940 as a metallurgist in the company's Eastern Research Laboratory at Harrison. He also served as a metallurgist in the metallurgical laboratory and the melting department of the company's plant in Harrison.

TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

With rolls, it pays to know which end is "up"



Cast steel structural mill roll shows good pass location to promote proper directional solidification.

There's a very good reason why every roll shipped by Mack-Hemp carries the word "DRAG" engraved on one wabbler. With all cast rolls, maximum strength and depth of sound metal tend to occur toward the *drag* end of the roll—the end at the bottom of the mold when the roll is being poured. This is because of the normal manner in which the "lines of solidification" form as the molten metal cools and solidifies. Also the pressure from the weight of the metal above helps increase the density of the metal in the drag end of the roll.

As you can see from the diagram at the left, the solidification lines angle gently outward as they rise toward the top or "cope" neck of the roll, forming a cone-shaped pattern. In general, these lines of solidification mark the boundary of the dense, homogeneous metal. As a result, there is more good metal in and near the drag end than at the cope end. To assist the roll user in quickly identifying the "bottom" end of his rolls, Mack-Hemp brands the drag wabbler of every roll produced in its foundries.

Locate the deepest passes in the DRAG end—Roll designers making drawings for blooming, rail and structural mill rolls should try to locate the deepest passes in the driven end of the roll, as illustrated. Directional solidification from drag to cope is then more easily accomplished and a sounder casting results.

We don't mean to imply that deep passes cannot be located at the cope end of the roll—in some instances, the overall mill layout, flow to the next mill, etc. may make it necessary to have the deepest pass in the cope end. When possible, however, this should be avoided since a deep pass in the cope end of the roll will restrict proper feeding of the lower portion of the roll.

Another factor—For maximum roll life, roll blueprints should call for the deepest passes at the driven end of the roll body. If you have a special reason why they must be located elsewhere, note it on the drawing; otherwise any roll maker worth his salt will ask you about it.

Another good rule to follow is to check with Mack-Hemp on any problem of roll selection or application. In a century and a quarter of making mill rolls, we have run across just about every conceivable situation involving the use of rolls. Our advice is yours for the asking. Feel free to telephone or write us at any time.

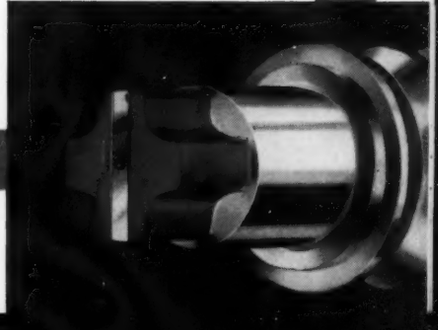
An important legend... for maximum roll life, the drag wabbler should be driven.

MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery



E. P. BERG

T. W. MATCHETT

G. W. OSTRAND

A. T. RICHTER

Eugene P. Berg has been appointed general manager of Link-Belt Co.'s Chicago, Ill., operations which consist of the Pershing Road and Caldwell plants. Mr. Berg has been with the company since 1937 and general manager of the Pershing Road plant since 1950. **T. Webster Matchett** has been appointed manager of Link-Belt's Caldwell plant, succeeding **G. Walter Ostrand** who has been general manager of the plant since 1936 and has retired after 47 years with the company. Mr. Matchett has been assistant manager of the Caldwell plant since October 1958. He was manager of Link-Belt's Chicago district sales office from 1948 to 1958.

A. T. Richter was promoted from Pittsburgh district sales manager to assistant general sales manager of the Midvale-Heppenstall Co. Mr. Richter started with the former Midvale Co. as a helper and melter on the electric furnaces. In 1948, after having several positions in the manufacturing division, Mr. Richter joined the Sales Department as a sales representative in the New York office. Later he was made district sales manager of the Pittsburgh office.

Lewis A. Wible was elected executive vice president of Union Electric Steel Corp. Mr. Wible has been with the firm for a number of years and has been vice president—sales and secretary. He will continue as secretary.

Mark W. Cresap, Jr., was elected president and chief executive officer, and **Gwilym A. Price**, chairman of the board, Westinghouse Electric Corp. The company's policy and finance committee, established January 1, 1958, was discontinued by the board. **E. V. Huggins,** vice president and chairman of the executive committee, and **John K. Hodnette,** executive vice president, were re-elected to these positions.

Otto J. Leone has been appointed engineer for steel industry applications by the Bristol Co. For the past 13 years, he has worked as a consultant and manufacturer's representative. His affiliations prior to that were with The Bristol Co. and United States Steel Corp.

J. O. Phillips has been promoted to manager of forging and die steel sales for Heppenstall Co. He has been assistant manager since 1957. He succeeds **George H. Wurster,** who now heads the Pittsburgh district sales office for Heppenstall Co. and Midvale-Heppenstall Co. Mr. Phillips started with the company in 1942, at a plant then operated at Eddystone, Pa. He was transferred to the Detroit, Mich., office in 1948 and to the Pittsburgh sales department in 1949. He was appointed assistant to the general manager of sales in 1952, assistant to the executive vice president in 1955, and assistant to the president in 1956.

John T. Lurcott has been named product engineer in the product engineering and development department of The Carpenter Steel Co.'s Alloy Tube Division.

Charles T. Smith has been appointed an assistant marketing manager of The Babcock & Wilcox Co.'s Boiler division. Mr. Smith was formerly sales engineer in the company's Philadelphia district office. Mr. Smith joined Babcock & Wilcox as a student engineer in 1947. After working as a service engineer in the Philadelphia and Chicago district offices for three years, he was transferred to the Philadelphia proposition department in 1951. He was made sales engineer in January, 1952.

Bernard W. Didsbury was named assistant general manager of Buffalo, N. Y., plant of Farrel-Birmingham Co., Inc. Mr. Didsbury first joined the company at Ansonia, Conn., in 1939. In 1952 he was named superintendent of the Ansonia machine and erecting departments, the position he held until this current advancement.

Robert R. Donaldson, vice president in charge of engineering for Hagan Chemicals & Controls, Inc., retired April 1 after more than 40 years with the firm. Starting as a draftsman and service engineer in 1918, he successively moved up to positions as chief service engineer, engineer in charge of research and design, chief engineer for the entire company and, in 1948, vice president in charge of engineering. He was elected to the board of directors in 1950.

W. W. Durand has been named chief metallurgist at the Crucible Steel Co.'s Park works in Pittsburgh, Pa. He replaces **F. L. Moffet** who was transferred to the company's headquarters and assigned to the technology department. Mr. Durand joined Crucible in 1937 as a metallurgical engineer at Park works. He became supervisor of the metallurgical laboratory in 1946, a position he held until his present appointment.

David N. Spierling has been appointed chief metallurgist, Detroit and Eastern Plants, Detroit Steel Corp. Mr. Spierling came to Detroit Steel in 1951 as a laboratory chemist. In 1952 he was made junior

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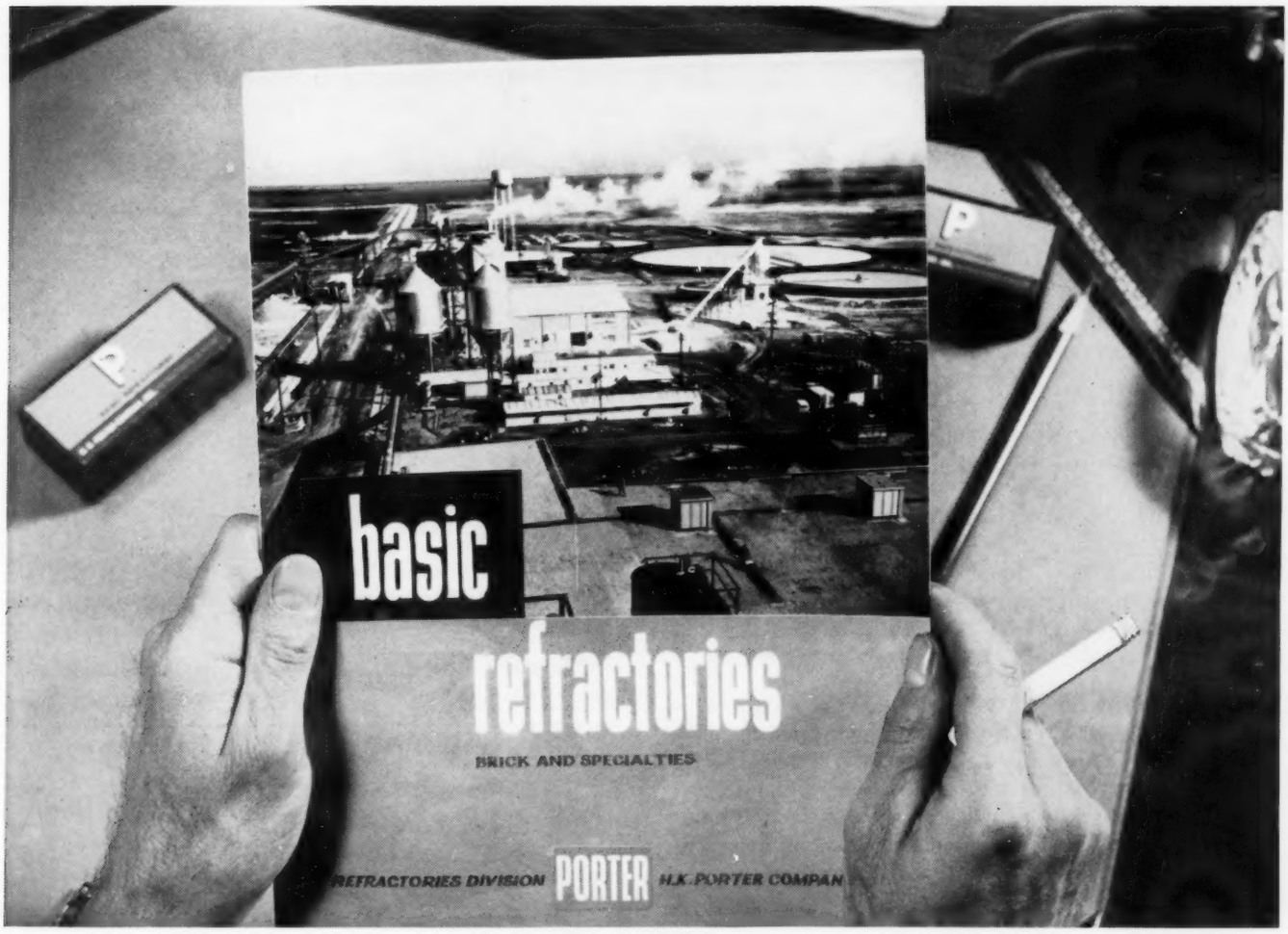
This comprehensive line is being produced at the new Porter Pascagoula Works . . . modern, fully integrated sea-water periclase and brick facilities for the exclusive production of basic refractories.

For information about this dependable, new source of supply, shipments, prices or assistance on *any* basic refractories problem, write: *Refractories Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pa.*



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metallurgist, and since 1953 has served as metallurgical contact representative for the corporation's Detroit strip mill.

R. T. Eakin has been elected to fill a vacancy on the board of directors of Latrobe Steel Co. Mr. Eakin is vice president of operations at Latrobe and joined the company last year from Allegheny Ludlum Steel Co., where he was works manager of the Brackenridge, Pa., plant.

Glenn F. Whiteley has been appointed manager of the Bridgeport, Conn., plant of Heppenstall Co. He succeeds **Edward W. Moffitt**, who was transferred to the Midvale-Heppenstall Co. plant in Philadelphia, Pa. Mr. Whiteley started with Heppenstall as a metallurgist at the Bridgeport plant in 1939. He became chief metallurgist in 1944 and was transferred to Indianapolis, Ind., when the company established its plant there in 1955. He was appointed manager of the Indianapolis plant in 1958.

Elmer Lynch has been retired as superintendent of the sheet and plate mills, Houston Plant, Sheffield Division, Armco Steel Corp. He will be retained as a consultant by the corporation.

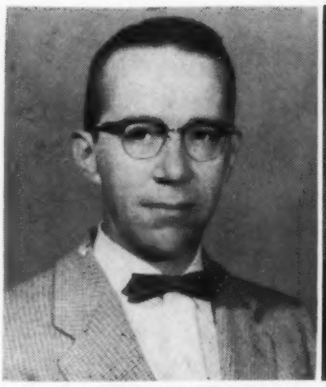
K. J. Kettner was appointed regional sales manager for the northern Ohio and Michigan district, Ramtite Co. At the same time **William J. Finn** was transferred to the sales department in Detroit, Mich., **Ron E. Opre** to the sales department in the Cleveland, Ohio, area and **Charles E. Miles** to the sales department at Youngstown, Ohio.

James H. Kelley has been appointed superintendent of the open hearth division at the Sparrows Point, Md., plant of Bethlehem Steel Co. At the same time, **Russell R. Jones** was named an assistant superintendent of the division, and **Bernard E. Hoffner,** assistant superintendent of the coke oven department.

Mr. Kelley has been with Bethlehem since 1935 and at the Sparrows Point plant since 1942, most recently as an assistant superintendent of the open hearth division. He succeeds **Rex McClain Baker**, who died April 6. Mr. Jones, who has been assistant superintendent of the coke oven department, has been with Bethlehem at Sparrows Point since 1948. Mr. Hoffner, until now, assistant to the superintendent of the coke oven department, has been with the company at Sparrows Point since 1942.

William Ward Powell, vice president of Mesta Machine Co. was awarded the degree of Doctor of Engineering (Honoris Causa), by the University of Milan. Mr. Powell is the first American ever to receive this degree, presented in recognition of his contributions to the development and improvement of the steel industry in Italy.

Paul R. Gravenstreter has been named district engineer for the newly established Detroit, Mich., district office of the Clark Controller Co. He moves to Detroit from the company's Cleveland headquarters, where he has been engineering manager of the Packaged Drive and Control Center Division since 1957. Mr. Gravenstreter joined Clark in 1954 and served in development engineering and commercial engineering capacities before becoming a division engineering manager.



P. R. GRAVENSTRETER

H. F. SCHULTE

Harold F. Schulte has been appointed chief engineer of Wheelabrator Corp. Mr. Schulte, with Wheelabrator Corp. since 1940, has been acting chief engineer since April, 1958.

Tedford M. Hendrickson has been named power engineer for The Youngstown Sheet and Tube Co., succeeding **Paul R. Duffey,** who retired March 31 after 19 years with the company. The assignment covers company works in both the Youngstown and Indiana Harbor Districts. Mr. Hendrickson has been assistant power engineer since 1956. He joined the company as a draftsman in the Engineering Department in 1947, and in 1948 was transferred to the Power Department. He was with the Ohio Works of United States Steel Corp. as a draftsman and junior power and fuel engineer.

Robert F. Sutherland has been appointed sales representative in New York for Refractories Division, H. K. Porter Co., Inc. Previously with A. P. Green Fire Brick Co. for 17 years in the New York area, Mr. Sutherland will now service all types of refractories accounts, and will work with **J. F. Kane,** New York district manager.

Obituaries

Rex McClain Baker, superintendent of the open hearth department at Bethlehem Steel Corp.'s Sparrows Point, Md., plant, died April 6. He started with Bethlehem Steel's Bethlehem, Pa., plant in 1916 and moved to the Sparrows Point plant in 1922. In 1940 he was appointed superintendent of all Sparrows Point open hearths.

Edward J. Seabold, consulting engineer, Towson, Md. died March 23.

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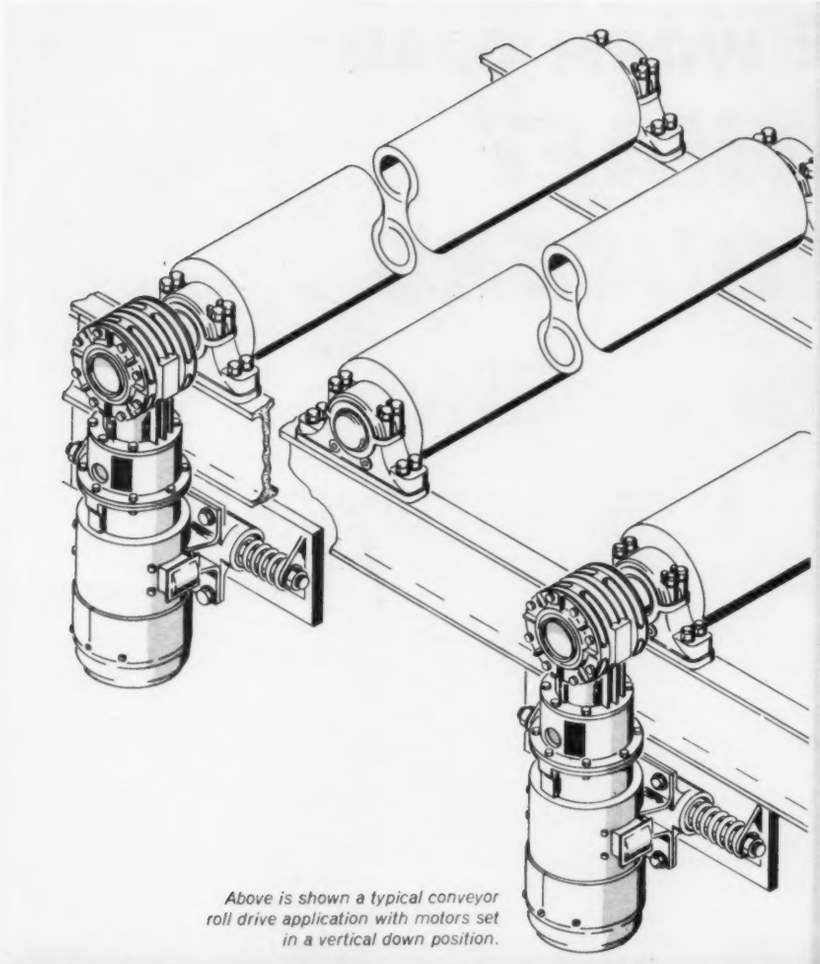

Above is shown a typical conveyor roll drive application with motors set in a vertical down position.

Flange mountings or all-motor base plate available to meet your requirements. Cast gray iron or steel housings available. Shaft sizes with "Celeron" bushing, maximum bore: 3-5/16"; without "Celeron" bushing, maximum bore: 4".

Gear Locking eliminated in this

WESTERN GEAR CONVEYOR ROLLER DRIVE

This shaft mounted conveyor roll drive was originally designed and manufactured for use as a sink roll drive in steel mill tin plating lines. Since this original unit, a considerable number have been sold in the steel industry for related uses. The unit contains a single reduction spiral bevel gear set. This is the secret of the no-locking feature, that eliminates costly down time. Gear teeth are hardened for maximum life. Heavy duty bearings are used to support all gearing loads. Horsepower ranges are normally from 2 to 5. Any motor to 1800 RPM can be used.

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CONE-DRIVE WORM GEAR HOLLOW SHAFT SPEED REDUCERS

provide greater flexibility in the design of your equipment

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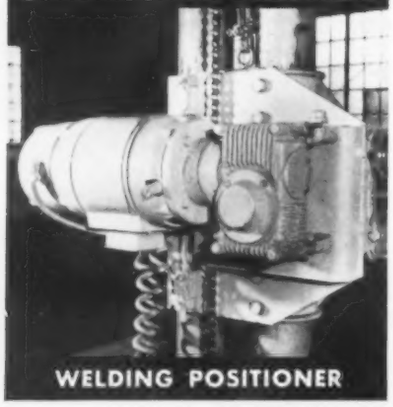


WELDING POSITIONER

Standard Cone-Drive hollow shaft speed reducers are available in four basic sizes (2, 2½, 3 and 3½ inch center distance units) to accommodate loads from fractional to 13 horsepower. They are built around the double-enveloping worm gear design and carry the same high ratings as standard Cone-Drive speed reducers.

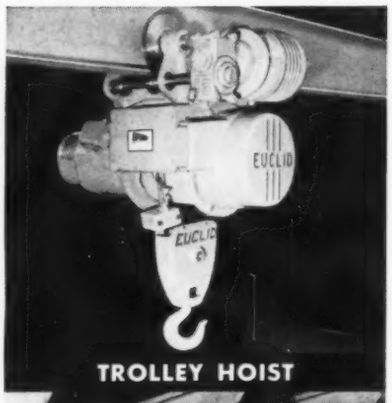
You, as a designer, will be particularly interested in the versatility of application and space savings made possible by the right angle design between input and output shafts.

The reducer is mounted directly on the driven shaft and requires only a simple bracket or torque arm to prevent it from rotating about the driven shaft.

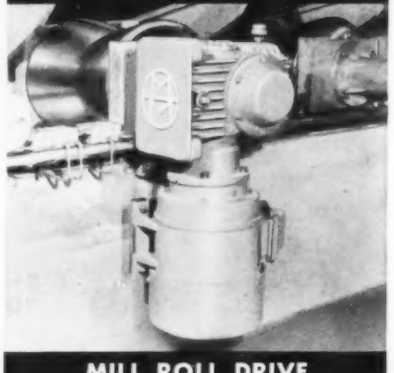
Construction is rugged enough to permit floor or wall mounting of Cone-Drive hollow shaft reducers and "hanging" the driven shaft on it (in certain applications), eliminating pillow blocks or bearings. Larger-than-necessary taper roller bearings and heavy-duty castings make this possible.

If a motorized reducer is desired, a simple, standard bell housing can be furnished for NEMA C-type face motors. The need for expensive couplings is eliminated since a tang-type drive sleeve and suitably machined worms are provided. When a hollow-shaft speed reducer and face-mounted motor are combined, no bed plate or mounting arrangement is required. Pulleys, belts, sheaves, etc., that might be troublesome or difficult to install are also eliminated.

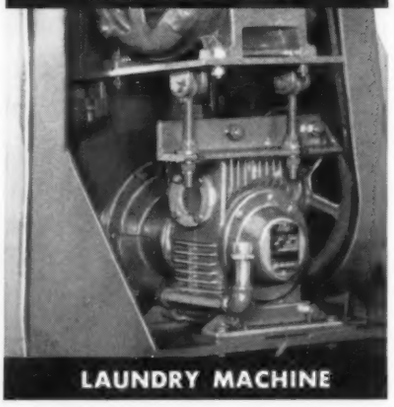
Ask for Bulletin CD-218.



TROLLEY HOIST



MILL ROLL DRIVE



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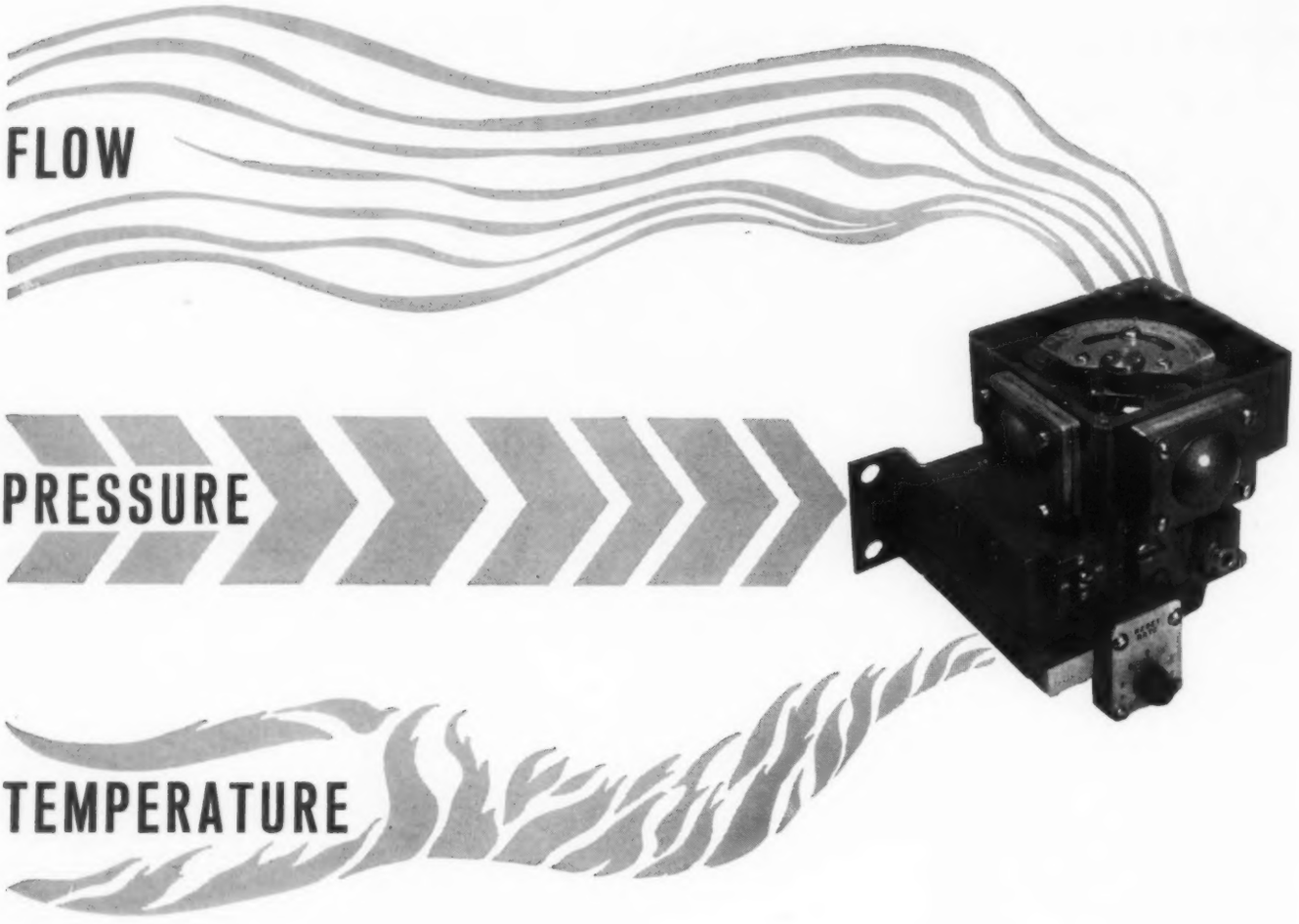

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Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action. Local or remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Republic Sales Offices are located in principal cities throughout the U.S.A. and Canada.

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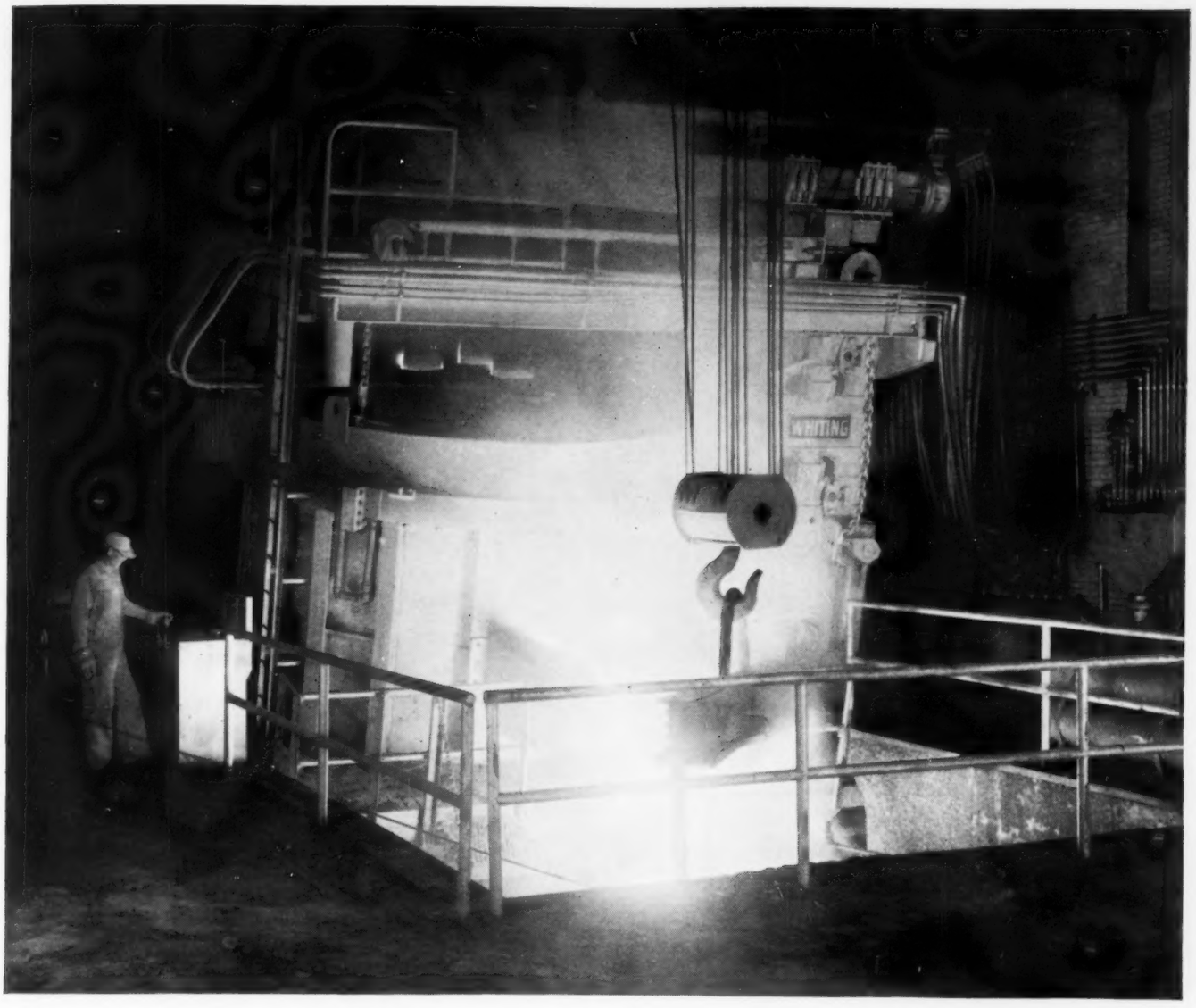

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Steel costs *can* be cut, by converting local scrap on the spot. Texas Steel Co. of Fort Worth, for example, now operates a 20-ton capacity Whiting Hydro-Arc electric furnace to produce billet-sized ingots ready for rolling. The very high efficiency of Hydro-Arc makes even medium or small scale operation profitable. This 12 foot 6 inch furnace energized with 7500 KVA substation equipment produces 23½ ton heats every 100 minutes. Whiting's superior electrode positioning control *constantly* keeps *proper* arc adjustment. Arcs burn at peak efficiency every moment. This means more heats per day at less cost.

An electric conversion installation can be surprisingly low cost, and highly profitable. For the full story, write for the Whiting Hydro-Arc Catalog, number FY-168. *Write today.*

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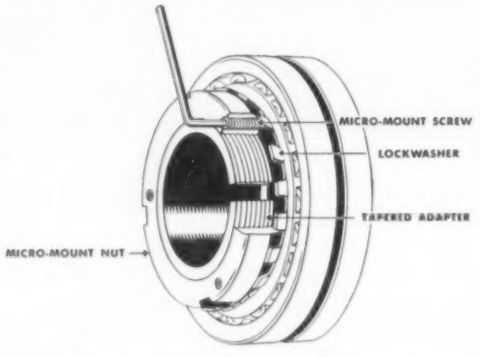

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Its rugged housing of close-grained semisteel withstands shock loads. It has a generous lubrication reservoir—for oil or grease. And standardized dimensions make Spher-Align interchangeable with all other similar units.

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5900 Union Street, Mishawaka, Indiana

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

Publication Service...

MAY, 1959

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Basic Linings

"Installing and Maintaining Basic Linings for High Frequency Induction Furnaces," is now available from the Kaiser Chemicals Division, Kaiser Aluminum & Chemical Sales, Inc. The pocket-sized booklet describes step-by-step the procedures in installing and patching rammed Periclase refractory linings in high frequency induction furnaces used for making quality and specialty steels. Included are instructions for using 102 Periclase, a high-magnesia product especially manufactured for induction furnaces and its companion product, 10–20 Periclase patching material for maintenance work. A special section is devoted to ramming or casting ladles with these materials.

(2) Centralized Lubrication

Application of modern centralized lubrication to reduce industrial operating costs and improve production is discussed in "A Report to Management," new 16-page brochure published by Lincoln Engineering Co., Division of The McNeil Machine and Engineering Co. The booklet explains the role of centralized lubrication—its advantages over manual methods of greasing and oiling industrial machinery; three economic areas of plant management where it can effect substantial savings; five practical steps for converting to automatic lubrication; case histories of uses in all major industries and detailed application data on basic centralized systems.

(3) Speed Reducers

Complete engineering information and specifications on their line of vertical-helical speed reducers is available from Western Gear Corp. The bulletin covers both double and triple reduction reducers and includes selection instructions covering many different types of installations. (Bulletin 5908)

(4) Condulets

Corrosion-resistant properties of a variety of metals and finishes used in their condulets are described in a bulletin published by Course-Hinds Co. The booklet contains first formal listings of Plast-A-Coat condulets for hazardous and nonhazardous locations. Charts showing the applications of each of the metals and finishes used on the condulets are also included. (Bulletin 2699)

(5) Anniversary Booklet

Harnischfeger Corp. has published an anniversary booklet to commemorate their 75 years of service to industry. The booklet describes and illustrates many of the company's products, such as, arc-welding electrodes, welding machines, electric hoists, overhead cranes, power cranes and shovels, soil stabilizers, electric excavators, etc.

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1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

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50	ATLAS CAR & MFG. CO.	BULLETIN 1283	Transfer cars
51	BABCOCK & WILCOX CO., THE	BULLETIN R-35	Refractory castables
52	BROOKS OIL CO., THE		Lubrication of industrial equipment
53	BROWNING AND CO., INC., VICTOR R.		Bridge cranes, trolleys and electric brakes
54	CLEVELAND TRAMRAIL DIVISION, CLEVELAND CRANE & ENGINEERING CO., THE	BOOKLET NO. 2008	Engineering and Application data
55	CLEVELAND WORM AND GEAR CO.	BULLETIN 145	Speed reducers
56	COLUMBUS McKINNON CHAIN CORP.	BULLETIN 100	Sling chains
57	CONE-DRIVE GEARS DIVISION, MICHIGAN TOOL CO.	BULLETIN CD-218	Hollow shaft speed reducers
58	ELECTRIC CONTROLLER & MFG. CO., THE, A DIVISION OF THE SQUARE D CO.	BULLETIN 1300 SB	All-welded magnets
59	ELLIOTT CO.	BULLETIN Q-23A	Elliott equipment for the steel industry and related industries
60	EUCLID ELECTRIC & MFG. CO., THE	BULLETINS 2210, 2220, 2230	Speed-responsive switches
61	FELLER ENGINEERING CO.	LEAFLET D9e	Automatic looplifter
62	FLY ASH ARRESTOR CORP.		Heavy duty fans
63	FOXBORO CO., THE	BULLETIN 20-14C	Magnetic flow meter
64	FRANTZ CO., INC., S. G.	BULLETIN PM-44	Magnetic separators
65	GARLOCK PACKING CO., THE	CATALOG 20	Oil seals
66	GENERAL REFRACTORIES CO.		Checker Bricks
67	HEIL PROCESS EQUIPMENT CORP.		Steam jet agitators
68	KINNEY ENGINEERS, INC., S. P.	BULLETIN 500.11	Strainers
69	LARCO, INC.	BULLETIN AC-587	Cab unit
70	LINK-BELT CO.	BOOK 2764	Materials handling, processing and power transmission machinery
71	MAGOR CAR CORP.		Air dump car
72	MEAD-MORRISON DIVISION, McKIERNAN-TERRY CORP.		Towers, bridges and grab buckets
73	PACIFIC COAST ENGINEERING CO.	BROCHURE 4-D	Cranes
74	PANNIER CORP., THE		Steel stamps
75	PENNSYLVANIA ENGINEERING CORP.		Equipment for steel industry
76	POST-GLOVER ELECTRIC CO., THE	BULLETIN 500	Steel grid resistors
77	REFRACTORIES DIVISION, H. K. PORTER CO., INC.	BULLETIN 71	Basic refractory products
78	ROCKWELL CO., W. S.	BULLETIN 580	Valves
79	SEL-REX CORP.		Guide to metallic power rectifiers
80	SKF INDUSTRIES, INC.	CATALOG 447	Steel pillow blocks
81	SPRAYING SYSTEMS CO.	CATALOG 24	Spray nozzles
82	TAYLOR CHAIN CO., INC., S. G.	BULLETIN 13	Alloy sling chains
83	TEXAS CO., THE		Management practices that control costs via organized lubrication
84	WESTERN PRECIPITATION CORP.	BULLETIN F105	Filter type collector unit
85	WHEELABRATOR CORP.	BULLETIN 128-D	Mechanical descaling
86	WHITING CORP., THE	CATALOG FY-168	Electric furnaces
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32- and 56-inch x 96-inch, 4-high reversing hot strip mill at the Terre Haute plant of Anaconda Aluminum Company.

BLAW-KNOX

ALUMINUM REDUCTION MILLS

Blaw-Knox designs and builds a full range of mills for the reduction of aluminum and other non-ferrous metals. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron, and steel rolls, Blaw-Knox Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat- and corrosion-resistant alloy castings.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery
Blaw-Knox Building · 300 Sixth Avenue
Pittsburgh 22, Pennsylvania

STOPS ACID WASTE IN CONTINUOUS PICKLING!

the Foxboro
Magnetic Flow Meter

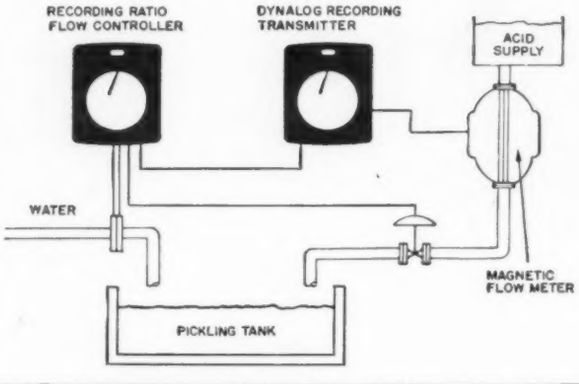
Precise, accurate ratioing of acid-to-water for continuous pickling lines—with no acid wasted. That's the type of control you'll get with a Foxboro Magnetic Flow Meter as the heart of your ratio control system.

Measuring flow of acids and other corrosive liquids is no problem for the Magnetic Flow Meter. This meter has no orifice plate, no pressure taps—no line restrictions of any kind. There's nothing to corrode—nothing to take apart and clean. The meter connects by electric cable to a remote Foxboro Dynalog* Electronic Recorder.

Magnetic Flow Meters install as simply as a length of pipe—operate continuously with an over-all system accuracy of ±1%. Water-acid ratios stay right where you set them. Best of all, waste of acid is completely eliminated.

Ask your nearby Foxboro Field Engineer about the Magnetic Flow Meter, or write today for Bulletin 20-14C, which contains full information. **The Foxboro Company, 585 Neponset Ave., Foxboro, Mass.** *Reg. U.S. Pat. Off.

Typical Water-Acid Ratio System
using a Foxboro Magnetic Flow Meter



FOXBORO
REG. U.S. PAT. OFF.
MAGNETIC FLOW METERS

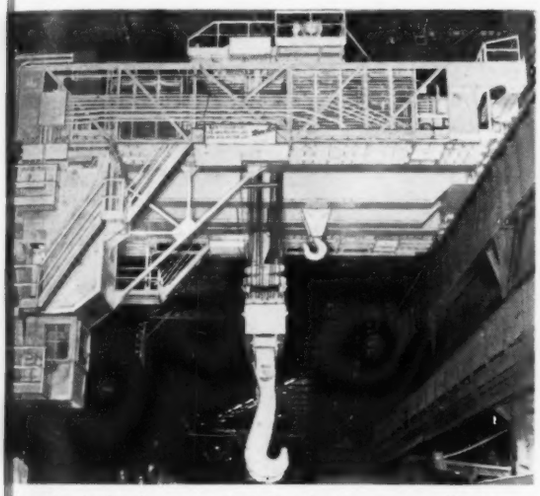
SC Crane speeds outdoor storage. This type of heavy industrial crane is custom built of standardized components. Capacities range from 5 to 40 tons; spans to 120 feet. 3 or 4 motor. Floor or cage operated.

SB Crane on the job in a steel warehouse. This class o standardized crane is built in capacities from 5 to 40 tons spans to 100 feet. Many built-in "plus values" insure to performance and low operating costs in the severest service

PROOF

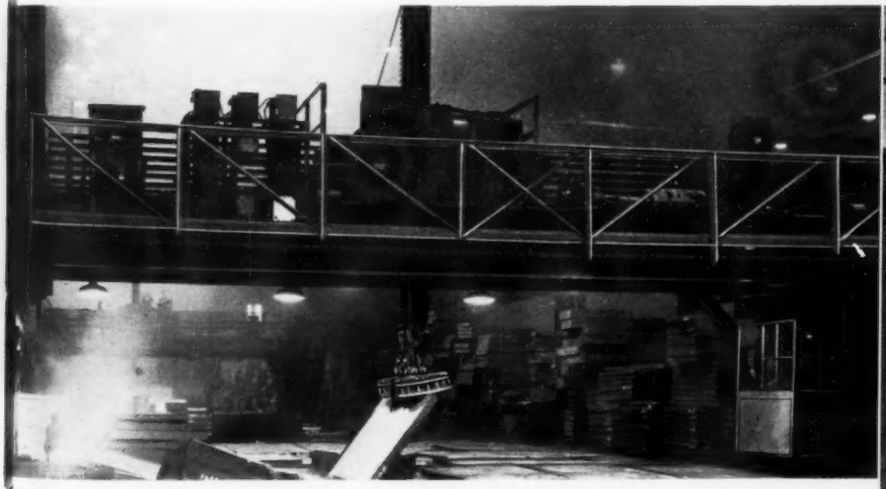
of Shaw-Box Crane quality and reliable performance is evidenced by more than 70 years of rapidly growing acceptance from all kinds of industries.

We build all types of cranes to AISE specs or to meet individual standards of structural durability and operational efficiency and economy. Your inquiry is invited.

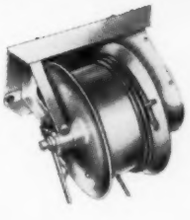


Shaw-Box Ladle Crane. A 4-girder, 9-motor crane with 54 foot span. 90-ton ladle holds 200 tons of molten steel. 75-ton auxiliary trolley handles lighter loads.

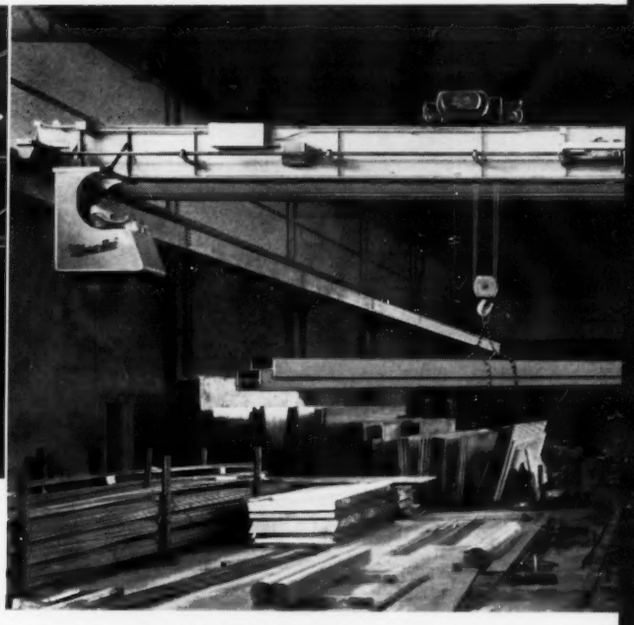
Shaw-Box Bucket Magnet Gantry Crane. Our gantries a serving the steel industry to handle plate, slabs, and scra We build them for other industries as well, in any desire capacity.



Shaw-Box Slab Turning Cranes do a tremendous job in conserving manpower and reducing costs around the clock. Rigid, non-whipping construction is combined with the utmost resistance to impacts.



Soaking Pit Cover Carriages are not only made by Shaw-Box, but we also produce the reliable spring drive cable reels that supply current to the carriages. These reels are also widely used on magnet equipped cranes.



Series "D" Load Lifter Cranes. Capacities to 20 tons, spans to feet. Designed for average industrial service. Components are highly standardized, you can buy your crane from a catalog.

59K-1

OVERHEAD CRANES FOR ALL INDUSTRY

Products of

MANNING, MAXWELL & MOORE, INC.

Shaw-Box Crane & Hoist Division • Muskegon, Michigan

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

Done hydraulically, with

NORTH AMERICAN EDGE CONTROL

SAVE MONEY!
Reclaim your interleaving paper. Ask about the new paper rewinder with edge control!

No waver, no weaving, no telescoping... North American *ends* tracking problems! Now winding and unwinding goes at top speed with precise tracking—accurate guiding into or from any processing unit!

Built for Men of Steel—rugged as a rolling mill, yet precise as a jeweled watch. North American Edge Control is in three compact units: the detector and the hydraulic relay which operate the power cylinder. Ideal for payoff reels, re-coilers or intermediate steering.

Learn why this unit out-performs any other control method, and at lower cost, too! We invite comparisons, so write now for literature or ask your nearby North American representative.

HYDRAULIC CONTROLS DIVISION

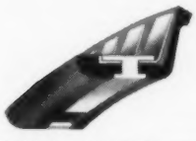
NORTH AMERICAN for COMBUSTION and Hydraulic Controls

The North American Mfg. Co.
Cleveland 5, Ohio

Model 64 assembled KLOZURE for back-up and wark rolls. Designed for large shafts, severe service.

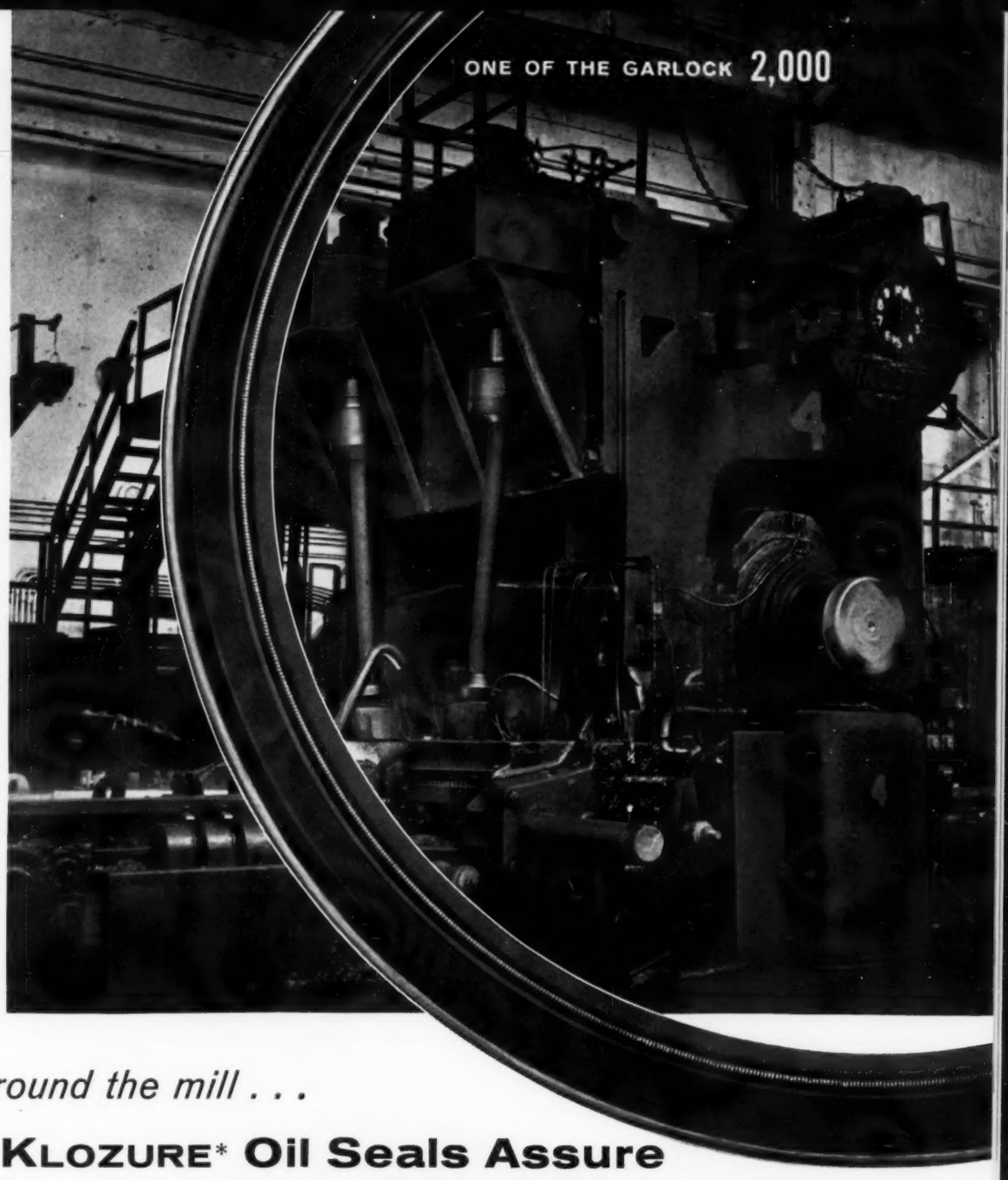
Model 82 bonded KLOZURE for back-up and work rolls, normal to high speeds. Comes as large as 44" diameter.

Model 21 or 23 Split- KLOZURE for installation without disassembly of equipment. Medium-speed service.



Model 142 face type KLOZURE for mill rolls. Designed to seal surfaces perpendicular in shaft.

Model 53 assembled KLOZURE for table rolls, normal to high speeds. Withstands temperatures to 250° F.



All around the mill . . .

Garlock KLOZURE* Oil Seals Assure Smooth, Dependable Operation

ON ALL PARTS OF A STEEL MILL, KLOZURE Oil Seals prevent leakage of vital bearing lubrication while protecting the bearings themselves from dirt, slag, scale, and spray. There's a KLOZURE design for *every* job, no matter how difficult.

MODEL 142, for example, keeps water splash and scale out of bearings at the shoulder of a mill roll. Model 53 is recommended for table rolls; Models 64 and 82 are applied for protecting bearings on back-up and work rolls. Where equipment can't be dismantled easily, Model 21 or 23 Split-KLOZURES are the choice.

ALL KLOZURES are oil and grease resistant . . . impervious to water, mild acids, alkalies . . . non-abrasive . . . withstand temperatures from −40°F to +250°F. For extreme conditions, Garlock furnishes sealing elements resistant to practically any fluid, and serviceable as high as +500°F.

KLOZURE Oil Seals are another part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Call your local Garlock representative, or write for Catalog 20.

*Registered Trademark

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

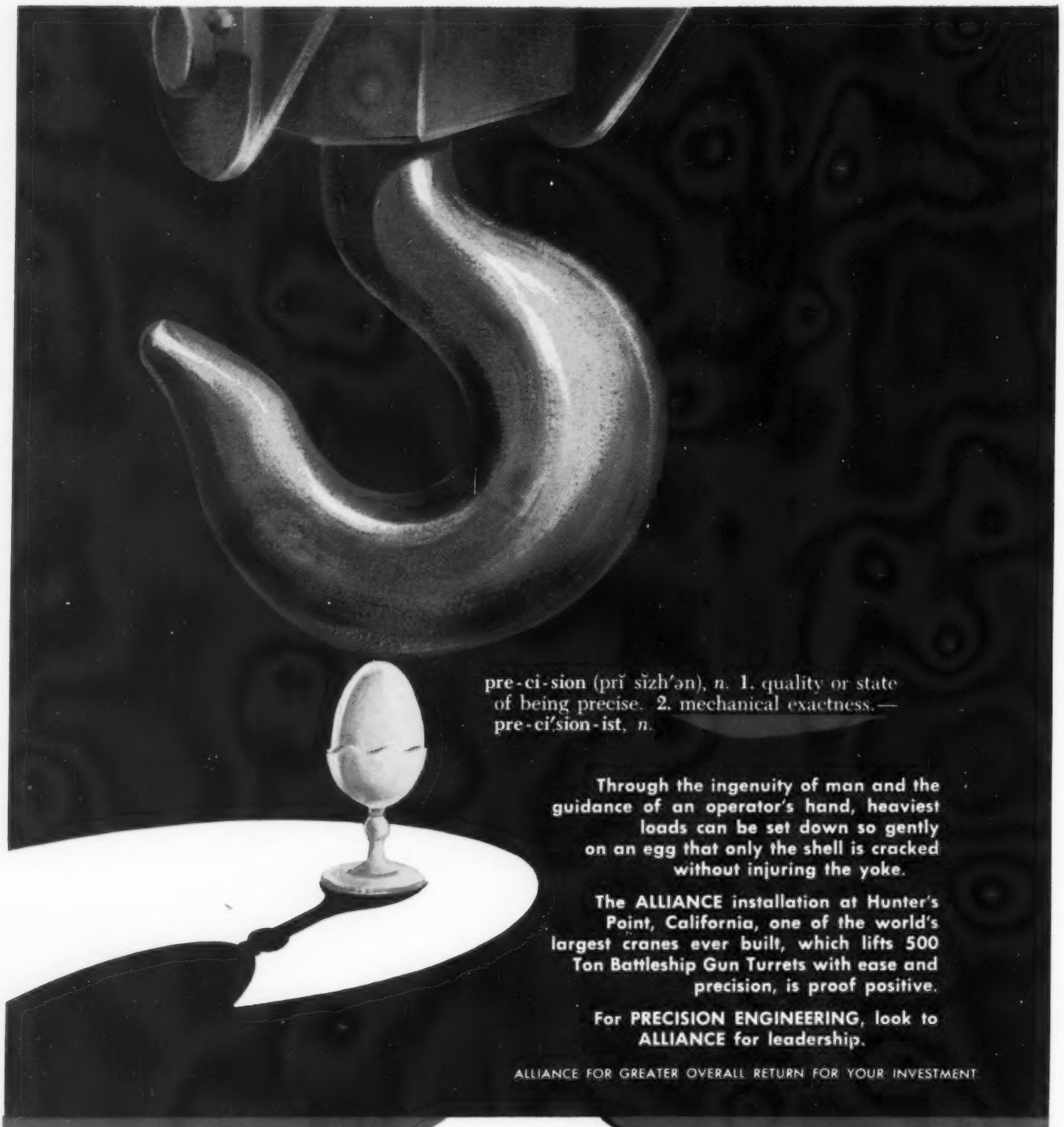
For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Canadian Division: The Garlock Packing Co. of Canada Ltd.

Plastics Division: United States Gasket Company



pre-ci-sion (prĭ sĭzh'ən), *n.* 1. quality or state of being precise. 2. mechanical exactness.— **pre-ci'sion-ist**, *n.*

Through the ingenuity of man and the guidance of an operator's hand, heaviest loads can be set down so gently on an egg that only the shell is cracked without injuring the yoke.

The ALLIANCE installation at Hunter's Point, California, one of the world's largest cranes ever built, which lifts 500 Ton Battleship Gun Turrets with ease and precision, is proof positive.

For PRECISION ENGINEERING, look to ALLIANCE for leadership.

ALLIANCE FOR GREATER OVERALL RETURN FOR YOUR INVESTMENT

Give us the Runway... and We'll Lift the World.

the Alliance machine company

Main Office Alliance, Ohio

Overhead Cranes * Gantry Cranes * Mill Cranes and Equipment * Hot Metal Cranes * Ladle Cranes * Stripper Cranes * Soaking Pit Cranes * Soaking Pit Cover Cranes * Charging Machines * Furnace Chargers * Slab Handling Cranes * Bucket Cranes * Magnet Cranes * Mold Yard Cranes * Skull Cracker Cranes * Ingot Buggies * Run-Out Tables * Car Dumpers * Special Mill Equipment * Ore & Coal Bridges * Loading & Unloading Towers Forging Manipulators * Forging Cranes * Power House & Dam Cranes * Dock & Pier Handling Equipment * Research, Development & Engineering Service * Licensees & Manufacturing Facilities in Other Countries

Equipment News...

CARD PROGRAM CONTROL

△ Completely automatic operation of blooming-slabbing mills is possible with a new card programmed control being proposed by Allis-Chalmers Manufacturing Co. Among the advantages of the system will be uniform rolling practices with resulting higher quality products and greater utilization of mill facilities.

With this control the operator will merely push a button to initiate action on an ingot. Complete rolling and manipulation of the ingot will then be done automatically.

Digital equipment will be used throughout to insure absolute accuracy except for high speed movements of the manipulator sideguards where analogue operation is briefly employed. Initiation and completion of this movement are controlled digitally however.

Of particular interest was the problem of turning the ingot 90 deg about its longitudinal axis for side rolling. This operation is complicated because of the changing cross-sectional area and shape after each pass and also because the operation involves a jockeying action of the manipulator sideguards and fingers.

A validity checking circuit, which assures reliability and accuracy by checking the code output for proper code and which checks the position code against itself, is being incorporated in the control. An error detection will result in a shutdown of the mill. The system will then be placed on manual operation until the cause is determined and corrected.

The same control, less the ingot turning equipment, can be readily modified for universal reversing plate and roughing mills.

GLASS HEAT SHIELD

△ A plate glass heat shield which reflects 65 per cent of long wave infrared has been developed by Corning Glass Works for use in commercial and industrial operations.

The Pyrex Brand Heat Shield is being offered for the protection and comfort of personnel working in areas of intense heat.

The window is covered with a thin, transparent metallic film. The heat literally bounces off the coating which is permanently bonded to the glass. The glass itself does not become hot.

The product has been used successfully as windows in steel mill pulpits and open hearth crane cabs. The shields have held up against heat, flying slag and splashing molten metal.

According to the manufacturer, the shield can be used to advantage to protect delicate instruments and as an effective means of reducing the load on air conditioning units.

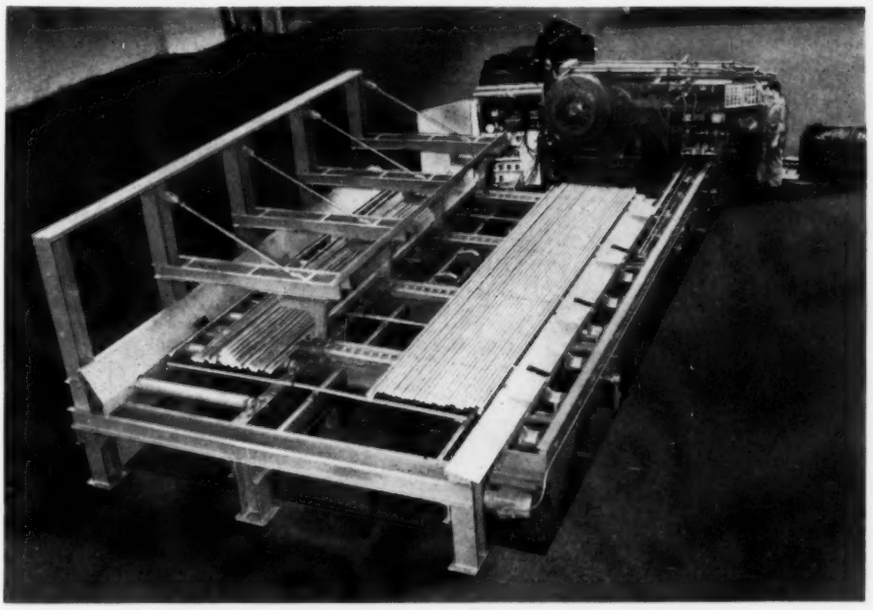
The heat shield is available in three standard sizes, 24 in. x 24 in., 24 in. x 36 in. and 24 in. x 48 in. Shields can be made to any size to meet specifications.

The low expansion glass has excellent thermal shock resistance and high mechanical strength. The reflective film, 16 millionths of an inch thick, is nonclouding. Like the glass, the coating is resistant to abrasion and chemical attack.

PNEUMATIC COMPUTER

△ A pneumatic pressure-ratio computer that measures compressor inlet and outlet pressures while simultaneously calculating the ratio of the two now is available from Hagan Chemicals & Controls, Inc. Out-

AUTOMATIC SHEAR CUTS HIGH TENSILE BARS



This automatic shearing unit, developed by The Hill Acme Co., will shear up to two in. diam high tensile material two pieces at a time—minimum 12 in. long to maximum 50 in. long pieces to be cut with automatic disposal of scrap ends of bars. With the use of one operator, open bundles of bar steel are loaded on a yard conveyor and transferred automatically onto a cross chain magazine, and discharged onto a double grooved feed conveyor. Two bars feed off the conveyor to a predetermined retractable length gage which automatically energizes the clutch on the shear making one cut. As the bars are cut, two more bars are automatically discharged to the feed conveyor producing fifty pieces of cut material per minute. As the pieces are cut, horizontal chains carry them to drop off chutes for deposit into reciprocating tote boxes, automatically stacking them. The entire operation can be overseen by one operator at close to 100 per cent efficiency. Standardized sizes have been established to minimize time required for change of length or diameter of bars.

More clean water at a lower cost with...

S.P.KINNEY

AUTOMATIC

SELF-CLEANING

STRAINERS

... for efficient removal and disposal of suspended particles from raw or process water and other liquids

- ✓ Over 1000 installations
- ✓ 2″ to 48″ pipeline sizes
- ✓ Installation on pressure or suction side of pump
- ✓ Over 8 billion gallons per day installed capacity
- ✓ Large variety of straining media

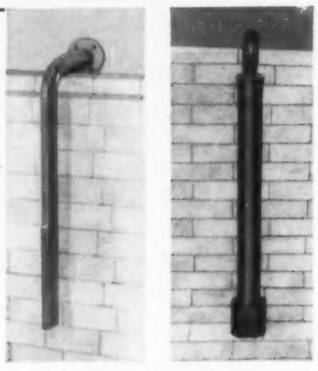
Write today for Bulletin 500.11 and list of installations

S.P. KINNEY ENGINEERS, Inc.
CARNEGIE, PENNSYLVANIA

FOR UNIFORM HEATING AND EFFICIENT AGITATION SPECIFY

HEIL of Cleveland

Steam Jet Agitators



Heil Steam Jets for Continuous Pickling Applications

they shorten the pickling cycle and increase tonnage output.

The standard for low-cost, continuous pickling of strip, or the batch pickling of sheets, coiled rods, wire and other products. Hundreds of successful installations.

Use of rugged, durable, lead extrusions, highly resistant to mechanical and thermal shock, assures long, maintenance-free operation. Heil exclusive Nocordal impervious graphite nozzles imbedded securely in the lead, at properly spaced intervals, provide efficient heating, uniform agitation, and prevents the steam from eroding the outlet.

Heil "E-4" Steam Jet Agitator System for Batch Pickling

Write for the Heil fully descriptive bulletins. They give complete details and specifications.

CHEMICAL-PROOF LININGS · TANKS HEATERS PLASTICS

HEIL PROCESS EQUIPMENT CORPORATION

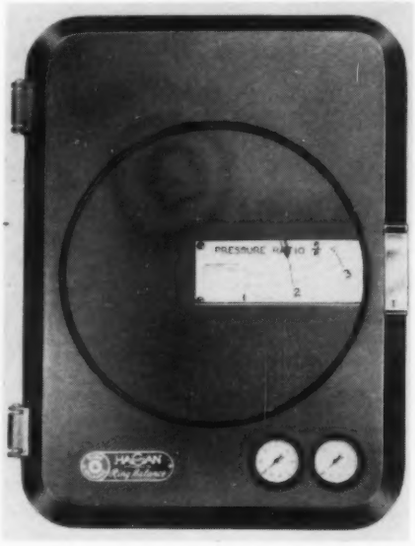
12901 Elmwood Ave. Cleveland 11, Ohio

standing features of the computer are wide range, flexibility, accuracy and pneumatic signal transmission.

Pressure-ratio is a key variable which must be regulated in order to prevent flow instability or surge in exhauster, compressor or blower control systems. The instrument indicates pressure-ratio on an integral scale and generates a pneumatic signal proportional to pressure-ratio for use in a control system.

The Model PR-O can be used in any other application which requires the calculation of the ratio of two pressures.

Pressure elements are available for use over a continuous range from



zero absolute to 500 psig. Under normal operating conditions, ratios of 1 to 5 can be measured accurately throughout a pressure turn down range of 20 to 1. Measured ratios may be increased as the ratio of maximum pressure values increases.

Output signal, in the ranges of 3–15 psig and 0–30 psig, may be used for recording or indicating instruments or for actuating elements of an automatic control system.

CONTROL SYSTEM

△ A new Allis-Chalmers control system, featuring magnetic amplifier speed regulators for revamping a 68-in. hot strip mill, is operating at an Eastern steel plant.

The new speed regulators provide a programmed variation of speed tension on the tail end of the strip, resulting in an improvement of gage uniformity.

Equipment includes six new magnetic amplifier speed regulators for the six finishing stand motors (five

"Research and development at National keep pace with expansion,"

reports Joe Marsalka, Metallurgist

"Expansion of plant and equipment are only part of the progress story at National Roll & Foundry Division. Our research and development program has made corresponding progress and, in addition, National and its roll customers benefit greatly through the research and development staff of the parent company, General Steel Castings.

"This expanded program has resulted in important developments which have increased the fine quality and dependability of National rolls. For example, in the steel foundry, a new quenching machine, developed by National, provides greater control in air or water quenching of alloy steel rolls.

"In the iron foundry, a new pressure ladle not only simplifies the production of nodular iron, but permits closer control of its physical properties.

"We are continually testing new ideas and new methods with one thought in mind . . . to give you the best in iron and steel rolls."

GENERAL STEEL CASTINGS

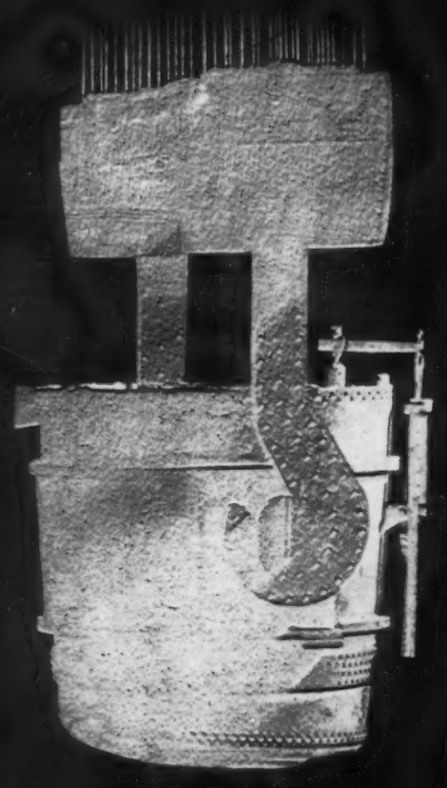
National Roll & Foundry Division

Avonmore (Westmoreland County) Pennsylvania

General Steel Castings Corporation: General Offices, Granite City, Ill.

Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.

HAUNTED BY DOWN TIME?



PACECO cranes can set your mind at ease. Rugged–dependable–with simplified maintenance requirements. PACECO cranes speed production and build profits.

benefit with PACECO'S newest crane developments

New concepts in crane controls, full anti-friction bearing machinery components, and compact trolley machinery arrangements mean lower first costs and minimum maintenance. PACECO'S 36 years of design and fabrication leadership make PACECO cranes better cranes to meet the rigid demands of mill operation. Put your specifications in the hands of crane craftsmen who minimize cost yet retain quality with superior performance.

LET PACECO BID YOUR NEXT MILL CRANE

Contact your nearest PACECO office or write for brochure 4-D now.

PACECO
"TAILORS OF STEEL"

PACIFIC COAST ENGINEERING CO.

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P.O. Drawer "E"
LAkehurst 2-6100

Torrance, California
(Los Angeles Area)
FAirfax 0-0341
Los Angeles—SPruce 5-1089

New York, New York
51 East 42nd Street
OXford 7-1475

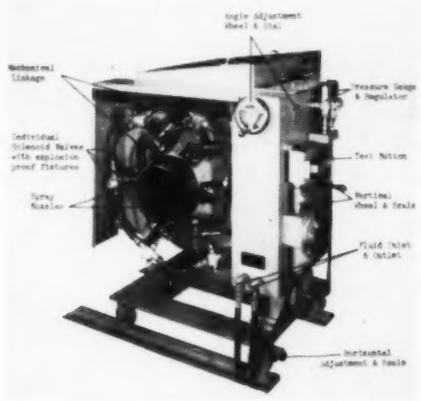
REPRESENTATIVE:
Houston 1, Texas
P.O. Box 1035
MOhawk 4-3504

4000-hp and one 3500-hp mill motors) and a bus voltage regulator for the six 3000-kw generators. New magnetic amplifier regulators for the main generator bus voltage and the speed and voltage reference supplies were also included. Necessary relays for interlocking and transferring into the existing control circuits were mounted on the rear panel of the control structure.

Features of the new control system include this application of the high gain magnetic amplifiers, and the novel mill construction where the regulator adjustments and metering devices are mounted on swinging doors in front of each panel section. The magnetic amplifier components are mounted back-to-back behind the doors to conserve space.

AIRLESS SPRAY UNIT

△ The Cleanola Co. announces development of an airless spray unit, the cone spray coater, which is designed to be integrated into production lines for applying mill type protective coatings—pigmented and unpigmented—on pipes, tubes, bars, angles and other structural shapes.



Coating unit is designed so that it can be integrated into the production line.

Heat and pressure, not air, accomplish the atomization. Timed spray cycle and synchronously adjustable spray heads reduce overspray to the point that direct recirculation to the feed system is not required. No recirculation means no loss of solvent, no premature oxidation of coating material and no contamination of feed system by mill scale and dirt. It is not necessary to add solvent to adjust viscosity, or to flush the machine after using.

Each coater, including the necessary auxiliary equipment—heater and pressure unit and electrical control panels—is designed specifically for each individual installation.

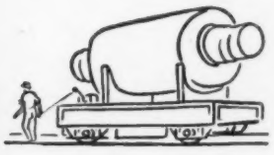
CAB-PULPIT HEATER

△ A new air circulating heater for use in crane cabs and pulpits is now being manufactured by Lintern Corp. The new heater provides for ventilation with ouside air and a dust filter is available.

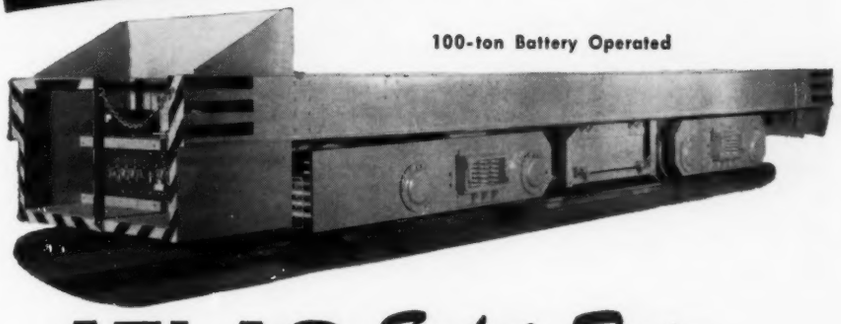
Chief advantages to the new heater is that air is uniformly circulated so that there can be no hot spots or cold spots.

The heater measures only 27 x 13 3/8 x 14 in., weighs 114 lb and delivers 500 cu ft of air per minute. It is available in two models—one that delivers 4 kw of heat and another that delivers 6 kw. It may be mounted on ceiling, wall or floor and the operator may control the heat by thermostat and the rate of air delivery by a two-position switch. A simple knife switch is provided to remove heater elements from the circuit, thus making it possible to

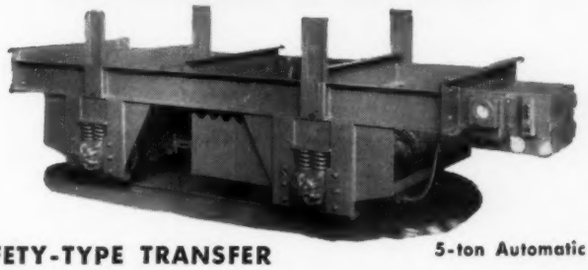
HANDLES THE BIG LOADS WITH BIG SAVINGS



100-ton Battery Operated



ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

Request "Walk-Along" Bulletin 1283.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

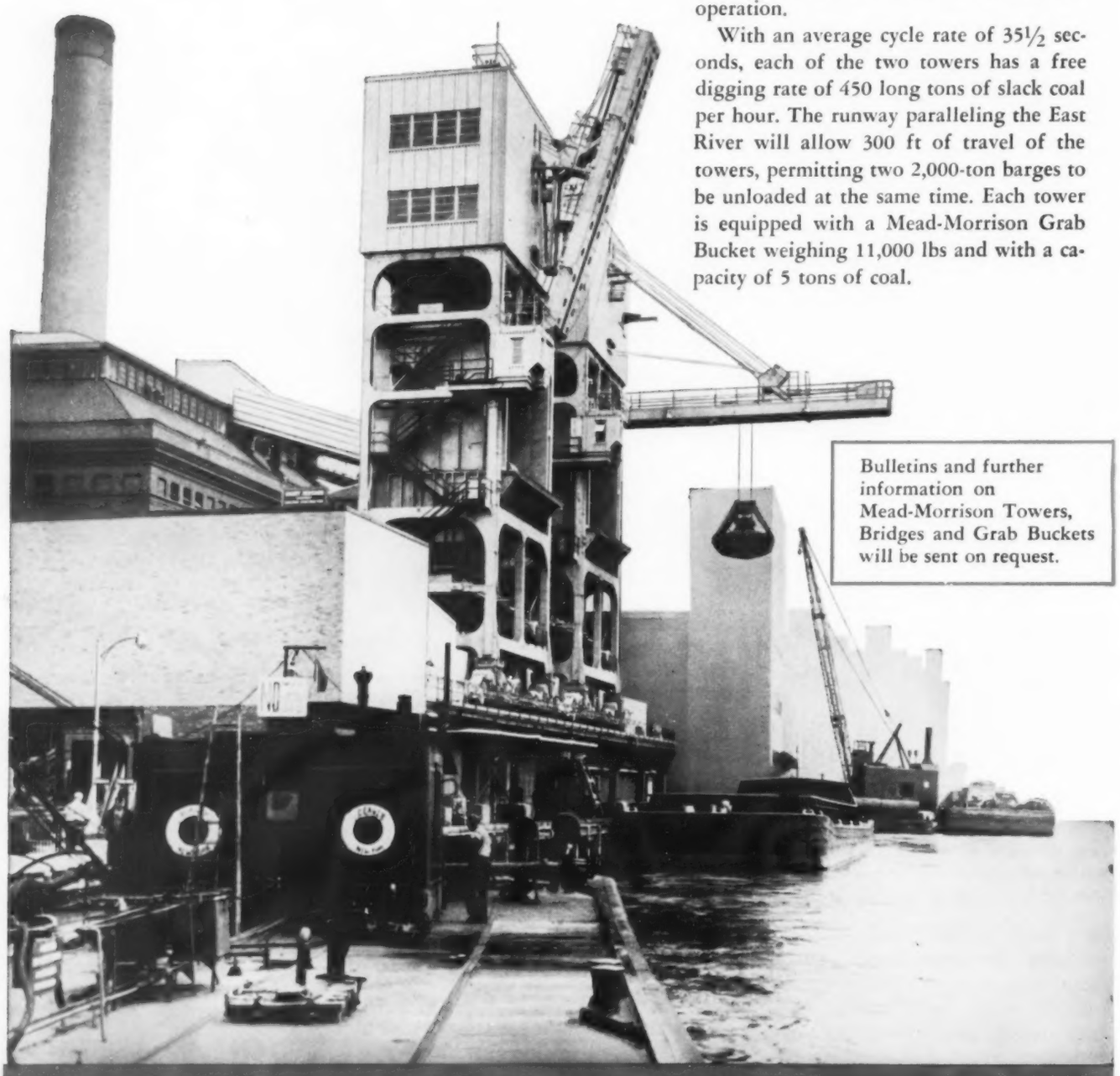
ENGINEERS AND MANUFACTURERS SINCE 1896

Speedy coal handling

for a New York subway power plant

The power station of the New York Transit Authority at 74th Street and East River has installed two new Mead-Morrison Coal Unloading Towers as part of its extensive modernization program to increase subway power. Because of their prominent position alongside the East River Drive, the towers were specially designed by Mead-Morrison to meet aesthetic standards as well as to include the most modern features for efficient operation.

With an average cycle rate of 35½ seconds, each of the two towers has a free digging rate of 450 long tons of slack coal per hour. The runway paralleling the East River will allow 300 ft of travel of the towers, permitting two 2,000-ton barges to be unloaded at the same time. Each tower is equipped with a Mead-Morrison Grab Bucket weighing 11,000 lbs and with a capacity of 5 tons of coal.



Bulletins and further information on Mead-Morrison Towers, Bridges and Grab Buckets will be sent on request.

MEAD-MORRISON

Division of McKIERNAN-TERRY CORPORATION • Manufacturing Engineers

HARRISON, NEW JERSEY

MK825

use the fan alone for air circulation during the summer.

DOUBLE CUP BEARINGS

△ The Timken Roller Bearing Co. has introduced a new line of "Pin" type double cup bearings. The "Pin" type double cup bearing has distinct advantages over the conventional double cup bearing on applications where there is an inherent tendency for the outer race or cup to creep or turn in the housing.

These bearings have been developed primarily for applications where the bearings are used with loose cup fits, unclamped in floating positions and where experience has indicated that a cup locking device is desirable. Tests on rolling mill drives and other applications have proved the effectiveness of this design.

A hollow pin located in the housing fits into the large countersunk hole in the cup O.D. While the pin prevents the cup from turning in the housing, it does not restrict axial float, normally required as a result of shaft or housing expansion. This design facilitates the highly desirable feature of insuring positive bearing lubrication by introducing the lubricant through the hollow pin direct to the center of the bearing.

These bearings are designed to be dimensionally interchangeable with conventional Timken double cup bearings. This will enable machinery builders or operators to take advantage of this advancement with a minimum of change to existing machinery.

Several methods of pinning cups are possible.

SPRAY MIX

△ A new and economical refractory material for use where continual servicing is required has been announced by Plibrico Co. It is useful, too, for making emergency repairs, thereby keeping the furnace in production until a shutdown may be feasible.

Plibrico Spray Mix is a refractory gunning mix usable with all types of wet mix or nozzle mix equipment with low rebound. It can also be troweled into place. Application can be made to either hot or cold walls.

The spray mix has excellent abrasion resistance and good acid resistance. Its service temperature range is from 200 to 2500 F. The fusion point of this material is P.C.E. Cone 29 (3020 F). Its weight per cu ft is 118 lb. Packaging is dry in 50-lb bags.

HOT METAL CAR LINING

△ Refractories Division, H. K. Porter Co., Inc., has developed a "balanced" refractory lining for hot metal cars that gives extra tonnage, lower lining costs and less downtime.

An Eastern steel mill, recently made the change in their 150-ton "Torpedo" ladles. Going from an all high-fired, superduty clay brick lining, they put Porter "Shamva" Mullite into the extreme wear sections—metal line, spouts and belt section of the "belly." This Porter "balanced" lining poured 120,000 tons as compared with the 72,000 tons the mill formerly got with an all-clay lining. Accompanying benefits were lower lining costs per ton

SUPERIOR
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FOR
Blast furnace linings
Blast furnace run-out troughs
Cupola linings
Steel pickling tanks
Standard sizes and shapes • Tested performances
Competent technical service • Superior chemical and metallurgical characteristics • Graphite brick also available.
May we give you a quotation?
ELECTRODE GLC DIVISION
GREAT LAKES CARBON CORPORATION
18 EAST 48TH STREET, NEW YORK 17, N.Y. • OFFICES IN PRINCIPAL CITIES

of steel and less downtime—greater availability.

BILLET GRAB

△ A new, heavy duty sheet-lifter type billet grab has been announced by the H. L. Bushman Co., Inc. The grab has an operational rotation of 270 degrees, with twin hook electric hoist suspension.

The design of the unit spaces the feet to pick up billets of various lengths resting on a roller conveyor. Lifting members are so spaced that they can be dropped between the rows to make contact with the billet. All motions of the suspended hoist, motor driven trolley, and back and forth actions of the grab are remotely controlled from a pulpit located away from the apparatus. Because of 600 to 700 F billet temperatures, the entire unit is equipped with specially insulated motors. Asbestos baffles are built into the chassis of the grab.

While the grab has a basic operational capacity of 20,000 lb, it can be supplied with greater capacities and wide variations of width range.

The grab is always locked in position. As a result, the legs cannot be spread unless the motor drive is actuated.

SCRAP HANDLER UNIT

△ A 1200 lb capacity, hydraulic scrap handler attachment capable of dumping at a height of seven feet has been developed for the Yale Y-18 industrial tractor shovel by Yale Materials Handling Division, The Yale & Towne Manufacturing Co.

High capacity of the clawlike unit permits handling large loads of lathe turnings, light gage blanking scraps, bales, hides, strips or other objects that do not easily conform to normal bucket type handling.

The attachment's hydraulic dumping action and high reach allow for loading this material into normal open truck carriers or collecting it in tall, space-saving containers or piles.

The attachment itself consists of three components: seven, rigid, carrying forks welded to a 48-in. wide carriage; four, more widely spaced, hydraulically controlled clamping forks which close against the carrying units to hold the load and separately controlled hydraulic kick-off forks which sweep material from the carrying surface in dumping.

Loads are picked up by ramming the attachment into a pile of scrap and then hydraulically closing the upper forks to secure the load before backing the tractor shovel from the pile.

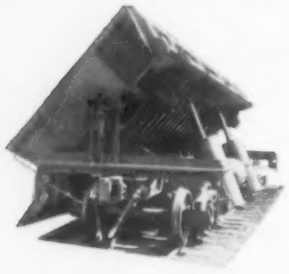
The Y-18's arm linkage permits low level carry for excellent visibility with an irregular load. The 45-degree tipback of the attachment brings the load closer to the center of gravity of the tractor shovel providing excellent stability in travel and a minimum of load spillage.

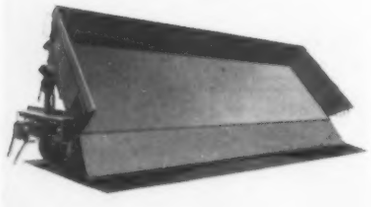
In dumping, the attachment is raised to the desired height, the upper forks raised and the whole unit tilted forward hydraulically. The kick-off forks are actuated last to remove any particles of scrap remaining within the attachment.

Action of the hold-down clamp is controlled by two, 3-in. diam double-acting cylinders. The kick-off

DESIGNED

FOR THE JOB—BUILT TO LAST!





Magor heavy duty air dump cars are designed to do just one job—speed-up waste disposal. Low height and greater size means faster loading—fewer trips. Automatic dumping eliminates expensive labor and crane equipment. Smooth car interiors eliminate "dead load" returns.

Made for the job, Magor Air Dump cars can cut your disposal costs as much as 40%! And because they're made to last, your maintenance costs will be cut too! Tapered body ends and double plate construction across load carrying members, for example, adds strength and years of service.

Magor engineers are ready to show you how to cut today's high costs down to size.

MAGOR

Write today for details and for the new folder describing the heavy duty air dump car.

MAGOR CAR CORPORATION

50 Church Street
New York 7, N.Y.

device is powered by a single cylinder.

The scrap handler attachment can be easily interchanged with a standard bucket or other handling device to provide great versatility in use of the equipment.

CAPACITOR EQUIPMENT

△ Large metal-enclosed capacitor equipments that use 50-kvar capacitor units and designed for distribution substations are now available from the Westinghouse Electric Corp.

Designated "Mod-ul-var 50," these capacitor equipments use 50-kvar capacitor units that are assembled into 1200-kvar modules. Field installation (outdoor or indoor) involves only bolting the required number of modules together. A separate bus entrance or circuit breaker compartment is merely bolted at one end to complete installation.

The "Mod-ul-var 50" capacitor equipments are available from 2400 to 13,800 volts (wye connected) and in bank sizes from 1200 to 6000 kvar. They are lower in price than equivalent equipment that use 25-kvar capacitors.

CONTOURING LATHE

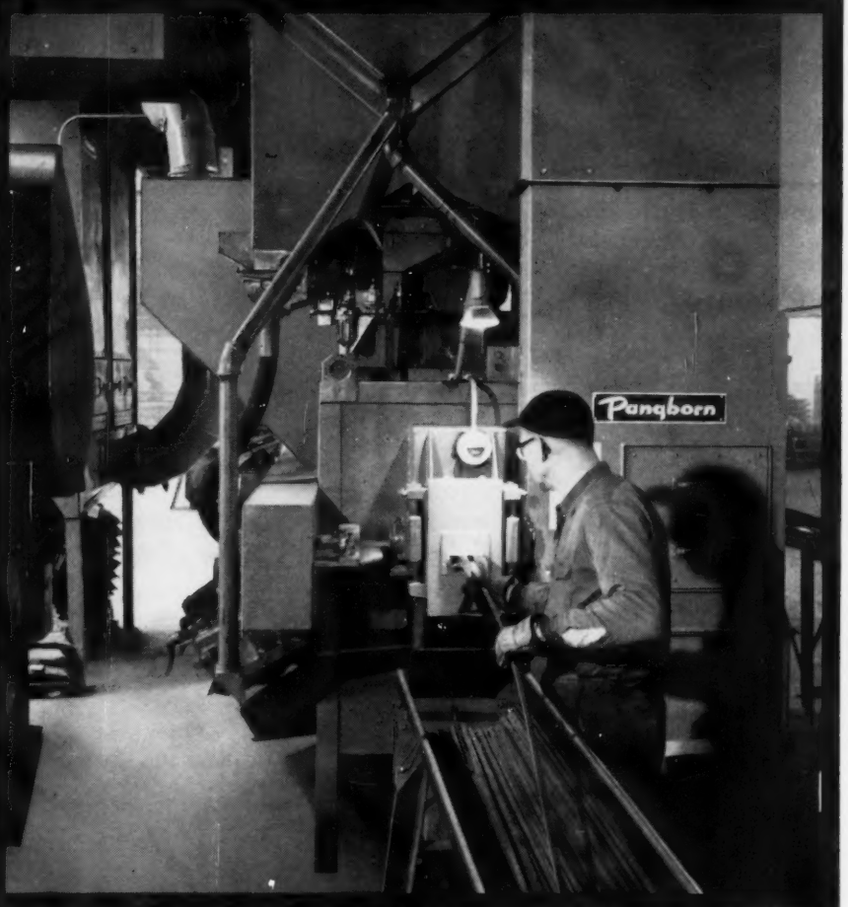
△ A 60-in. hydraulically-operated automatic roll contouring lathe, installed in the roll shop of United States Steel Corp.'s South Works, Chicago, is helping to slash roll backlogs at twice the previous rate.

Manufactured by the Mackintosh-Hemphill Division, E. W. Bliss Co., the big lathe utilizes a hydraulic tracing unit which permits accuracy within 0.001 in. with even the most complex roll configuration. The extremely sensitive hydraulic tracing head moves along a master template, translating the passes in the template into smooth hydraulic impulses that guide the cutting tool.

In operation at the South Works' roll shop for less than a year, the lathe has already helped reduce roll turning backlogs. It has handled a 53 x 100-in. roughing plate mill roll in less than half the time usually required to turn it, cutting turning time from 49½ hr to just 20 hr.

Under these conditions, the average metal removal rate of the lathe is between 84 and 86 cu in. per min-

ROTOBLAST DESCALING SAVES $75 A DAY



Pangborn Rotoblast Descaling Machine makes cost-cutting automation possible at Bustin Steel

At Bustin Steel Co., Dover, N. J., hot rolled steel bars are descaled by a Pangborn Rotoblast Machine at rates up to 180 linear feet per minute. This speed of operation plus the perfect quality of work—eliminating oiling and degreasing operations later—permits inserting this Rotoblast Machine directly at the head of the production line, working toward a completely automatic manufacturing operation.

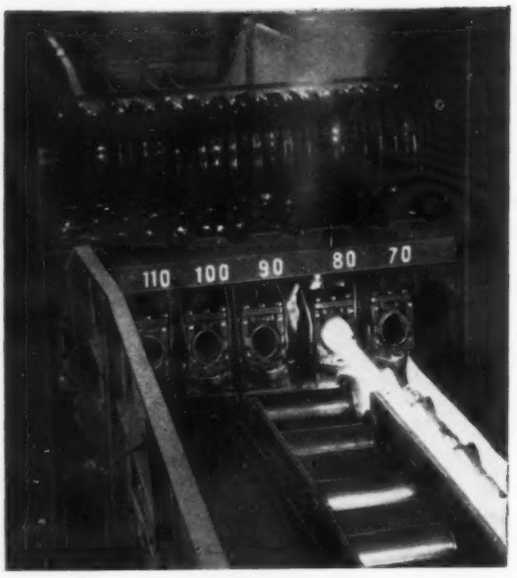
The operating cost of this machine saves Bustin at least $75 a day compared to pickling, *plus* the cost of degreasing *plus* savings resulting from longer tool and die life.

For information on how Pangborn Rotoblast can save *you* money, write PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment and Rotoblast Steel Shot and Grit.*

Pangborn

CLEANS IT FAST WITH ROTOBLAST®

8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill



Nos. 125 and 155 roller guides fitted in a 27 1/2 in. (700 mm.) diameter, three-high stand for rolling 2 3/4, 3 3/16, 3 9/16, 4, 4 3/8 and 4 7/8 in. (70, 80, 90, 100, 110 and 124 mm.).

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

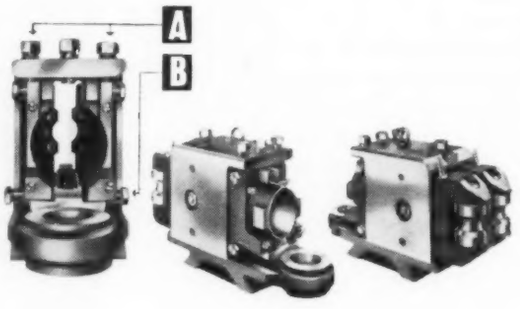
2 The rollers are mounted on leaf springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be thick, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.



7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and drawing oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mill. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

PS *Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.*

MORGÅRDSHAMMAR

MORGÅRDSHAMMARS MEK VERKSTADS AB • MORGÅRDSHAMMAR • SWEDEN

Telegrams: Morgårdshammar, Ludvika. Sweden

SOLE AGENT FOR THE US:
K.W. Atwater Engineering, Inc.
401-03 Butler Street
Pittsburgh 23, P.A.

ute on half the 150 hp used to drive it, surpassing what has generally been considered an average peak rate of 1 hp per cu in. per minute. South Works' roll shop has removed as much as 90 cu in. of metal per minute when rough finishing a mild steel, low carbon roll.

The lathe's hydraulic tracing system requires no specially trained personnel, and its control system is easily understood by the operator.

MAGNESIUM ALLOY

△ More efficient production of ductile iron is now achieved with a new high-magnesium silicon-base alloy supplied by Union Carbide Metals Co., division of Union Carbide Corp. Utilizing a new technique known as "plunging," the new "EM" alloy 55 is a source of magnesium that gives ductile iron its special properties.

In use, "EM" alloy 55 is placed in a refractory basket and plunged into a ladle of iron. This new technique yields magnesium recoveries of up to 50 per cent—almost twice as much as can be recovered with open-ladle treatments using more dilute magnesium alloys.

Plunging "EM" alloy 55 is not difficult and does not require elaborate equipment. The alloy's high-magnesium content permits use of less material than when plunging with more dilute alloys, minimizing temperature loss. The alloy's composition also minimizes the pyrotechnics that normally accompany magnesium treatments.

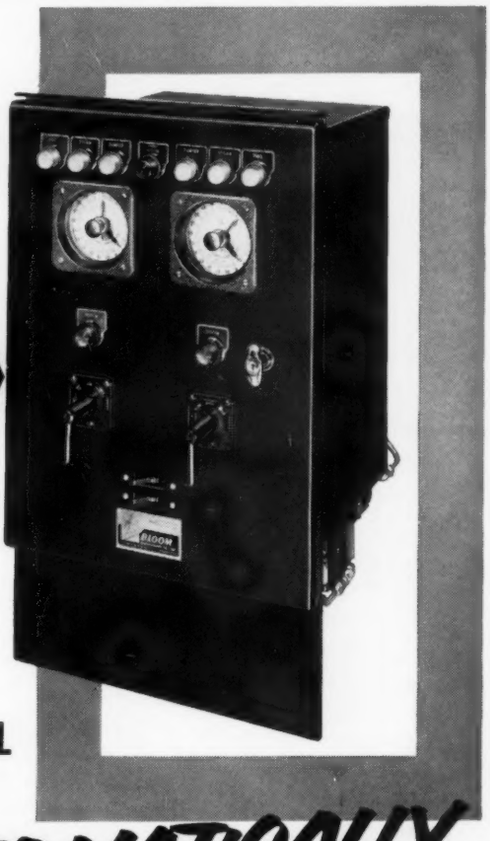
The composition of the new alloy is 30 to 32 per cent magnesium, 50 to 55 per cent silicon, 4 to 5 per cent calcium and 1 per cent mischmetal.

Book Reviews

"Engineering Manual," Robert H. Perry, editor-in-chief, has been recently published by the McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y. The book contains 680 pages, 5 x 7½in., is cloth bound and sells for $9.50. This book prepared by a staff of specialists, is a practical reference of data and methods in architectural, chemical, civil, electrical, mechanial and nuclear engineering. The book covers the major phases of engineering, structural design of buildings, highway and traffic engineering, over-all coverage of a-c and d-c circuits and machines, to recommended practices covering requirements in the nuclear power field. The book includes the facts, methods and procedures in each field, answers hundreds of questions that arise in day-to-day engineering assignments, and shows, in many cases, complete computations necessary to solve difficult problems, thus providing a dependable review of, or reference to, both fundamentals and applications. Mathematics, mathematical tables and physical and chemical data essential to all engineering are provided in three separate sections prefacing the manual; specialized tables, graphs, charts, formulas and many other practical aids are presented within the appropriate engineering sections.

"The Heating Ventilating Air Conditioning Guide for 1959," 37th edition, has recently been published by the American Society of Heating and Air-Conditioning Engineers, 62 Worth Street, New York 13, N. Y. The book contains a 768-page technical data section, as well as a catalog data section of 461 pages, 8½ x 11 in., is cloth bound and sells for

The BLOOM Time-Cycle Reversal Unit

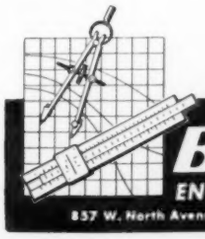


assures FULL, FAST AND EFFICIENT REVERSAL OF REGENERATIVE FURNACES AUTOMATICALLY

This complete, compact, factory-tested unit provides a combination electric-pneumatic system for Open Hearth Furnace and Soaking Pit reversal. It elimnates reversal puffing and shortens reversal period. (10 to 15 seconds easily accomplished).

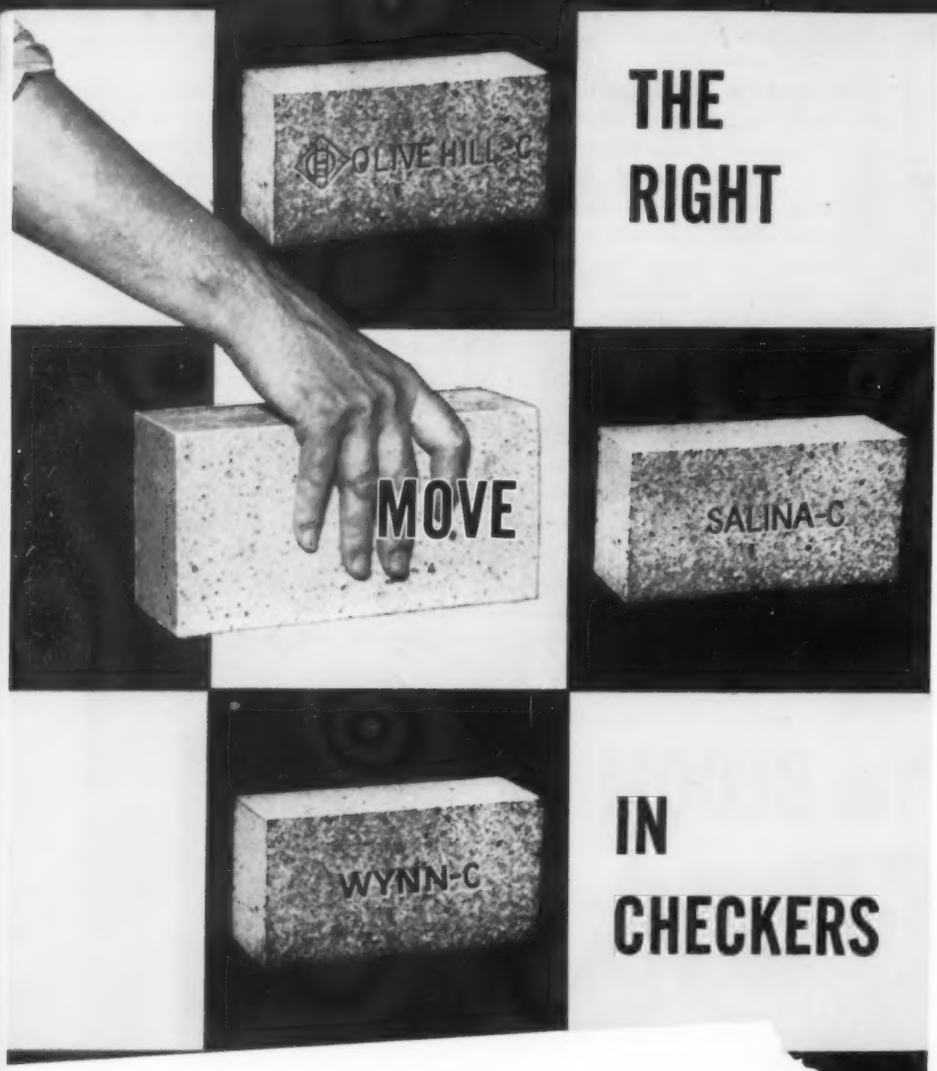
Shorter reversal cycle improves furnace life.

These units have been in continuous service for nine years. Trouble-free maintenance.



BLOOM ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

WRITE or phone for complete information on the Bloom Time-Cycle Reversal Unit.



THE RIGHT MOVE IN CHECKERS

General Refractories offers **superior** high duty fireclay checker brick; possessing all four properties recognized as the criteria for long life in regenerator chambers — high density, low porosity, high strength and refractoriness.

High density and low porosity are needed to insure volume stability, optimum heat transfer and minimum penetration of flux-bearing gases. High refractoriness, coupled with these other properties, is needed to withstand the temperatures prevalent in most regenerator chambers.

Any one of these properties by itself cannot describe an excellent checker. It is the combination of all these properties in one product that produces a superior checker brick.

GREFCO checker brick possess ***all*** these attributes. Manufactured from select, highly refractory fire clays; by GREFCO's unique double-tempering process; pressed in special dual-action, deairing power presses, fired to high temperature in tunnel kilns; and given a final rigid inspection for accurate size and quality; General Refractories' "C" brands are superior checkers. Surely, "THE RIGHT MOVE IN CHECKERS" is to — GREFCO!

WRITE FOR NEW LITERATURE ON CHECKER BRICKS

GREFCO

GENERAL REFRACTORIES COMPANY
Philadelphia 2, Pa.

$12.00. This edition follows the same general format of previous editions and is divided into 12 general sections: fundamentals; environment, comfort, and physiological principles; heating and cooling loads; room heating and cooling methods and equipment; air systems and equipment; steam and water systems and equipment; heat generating methods and equipment; refrigeration, spray apparatus, and sorbents; controls, instruments, and motors; specific applications; industrial systems; general. All subjects have been revised and rewritten to include the latest, up-to-date methods and information; five new chapters have been included: high temperature water systems; the heat pump; evaporative air cooling and humidification and snow melting. The catalog data section contains products of 309 manufacturers of heating, ventilating, cooling and air-conditioning equipment; it includes an equipment index broken down under numerous headings. This edition contains working charts and tables including 286 new or revised diagrams and charts.

"Electrical Safety" by H. W. Swann has been published recently by the philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 292 pages, $5\frac{1}{2}$ x $8\frac{1}{2}$ in., is cloth bound and sells for $15.00. The book is a comprehensive survey on electrical safety. The author has used as his main theme the British Factory Electricity Regulations, and discusses the technical interest of practice and progress, together with the regulations. Included also are chapters on physical effects of electricity, on domestic usage and details on hospitals and static. Numerous diagrams, tables, line drawings and photographs are employed to illustrate and explain the text.

"NEMA Standards Publication— Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy," NEMA Pub. No. WC 3-1959, March, 1959, has been recently published by the National Electrical Manufacturers Assn., 155 East 44th Street, New York 17, N. Y. Both the Insulated Power Cable Engineers Association and NEMA have approved this

so National rebuilds and ships motor in 4½ days

FAILURE of this slip-ring induction motor threatened a shutdown of service. So the owner shipped the motor to National Electric Coil – to get it rebuilt fast and rebuilt right.

In just 4½ working days, here's what National did: *designed* and built both stator and rotor coils, rebabbitted the bearings, turned the slip rings, repaired stator laminations, rewound stator and rotor, dynamically balanced the rotor, performed complete checkout testing, crated, loaded and started the motor on its return trip!

For service when you need it, it's wise to have this responsible, competent organization on your electrical machinery team. Call or write for full information.

McGRAW EDISON

National Electric Coil

DIVISION OF McGRAW-EDISON COMPANY
COLUMBUS 16, OHIO

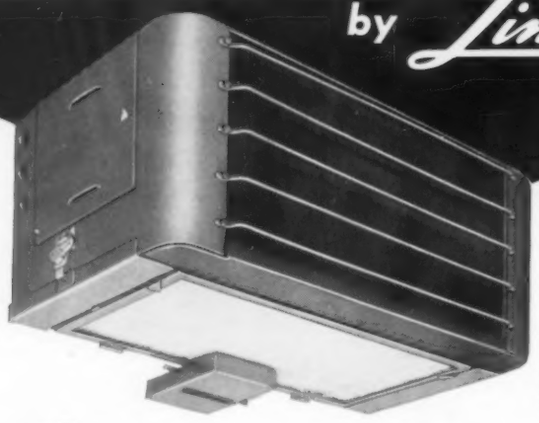
ELECTRICAL ENGINEERS • MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS • REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

publication which gives detailed information on conductors; insulation; shielding and coverings; cabling, fillers, binders and circuit identification; testing and test methods; pole and bracket cable; nonmetallic neoprene-jacketed mine power cables; preassembled aerial cable using copper conductors; and neutral-supported secondary and service drop cables. Copies are available from NEMA at $4.00 per copy.

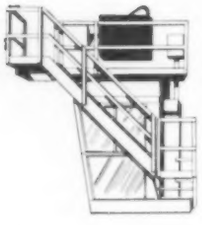
"NEMA Standards Publication—Color Coding of Wires and Cables," Pub. No. WC-1959, April, 1959, has recently been published by the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N. Y. The standard covers the color coding of the following types of wires, cables and cords: asbestos, asbestos-varnished cloth and asbestos-thermoplastic insulated wires and cables; textile coverings for flexible cords; and POSJ flexible cords; rubber-insulated wires and cables. Copies are available from NEMA at 30¢ per copy.

NEW CAB UNIT

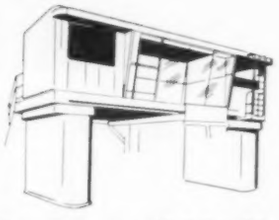
by Lintern



Ceiling Mounted Cab Unit



for Cabs and Pulpits



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"Solid State Magnetic and Dielectric Devices," edited by Harold W. Katz, has been recently published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 542 pages, 6 x 9 in., is cloth bound, and sells for $13.50. The book contains data which covers an inclusive treatment of the theory and application of the devices developed from ferrites and titanates. Here is a complete account of the solid state devices and components, with the exception of the transistor. Beginning with a classical treatment of magnetization and polarization, the essential electric properties, the book shows the general application of these principles to electrochemical phenomena to square loop material and to microwave frequencies; and also concerns itself with certain magnetic and dielectric devices. Also discussed are new computer components, new materials for filters and delay lines. Information is also included on: miniaturized filters, the theory of magnetic recording and microwave application. Formulas, line drawings, equations, charts and diagrams are employed to explain and illustrate the text.

"Air Pollution Control" by W. L. Faith has been published recently by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 259 pages, 6 x 9 in., is cloth bound, and sells for $8.50. The book presents the basic facts, in language easily understood by the nonspecialist, that must be considered in any air pollution control program, whether voluntary or required by law, and presents a better understanding of the more common air pollution problems, the available means of assessing the magnitude of the problem, and appropriate methods of abatement. It contains an explanation of the effect of air pollution and the importance of meteorological variables, it discusses the nature and source of the more common air pollutants, and considers in detail methods of determining the amounts of various contaminants in the air, the most appropriate means of controlling emissions at the source, and the legal means available for control. The newer aspects of air pollution, particularly the automobile exhaust problem and the hazard

(*Please turn to page 234*)

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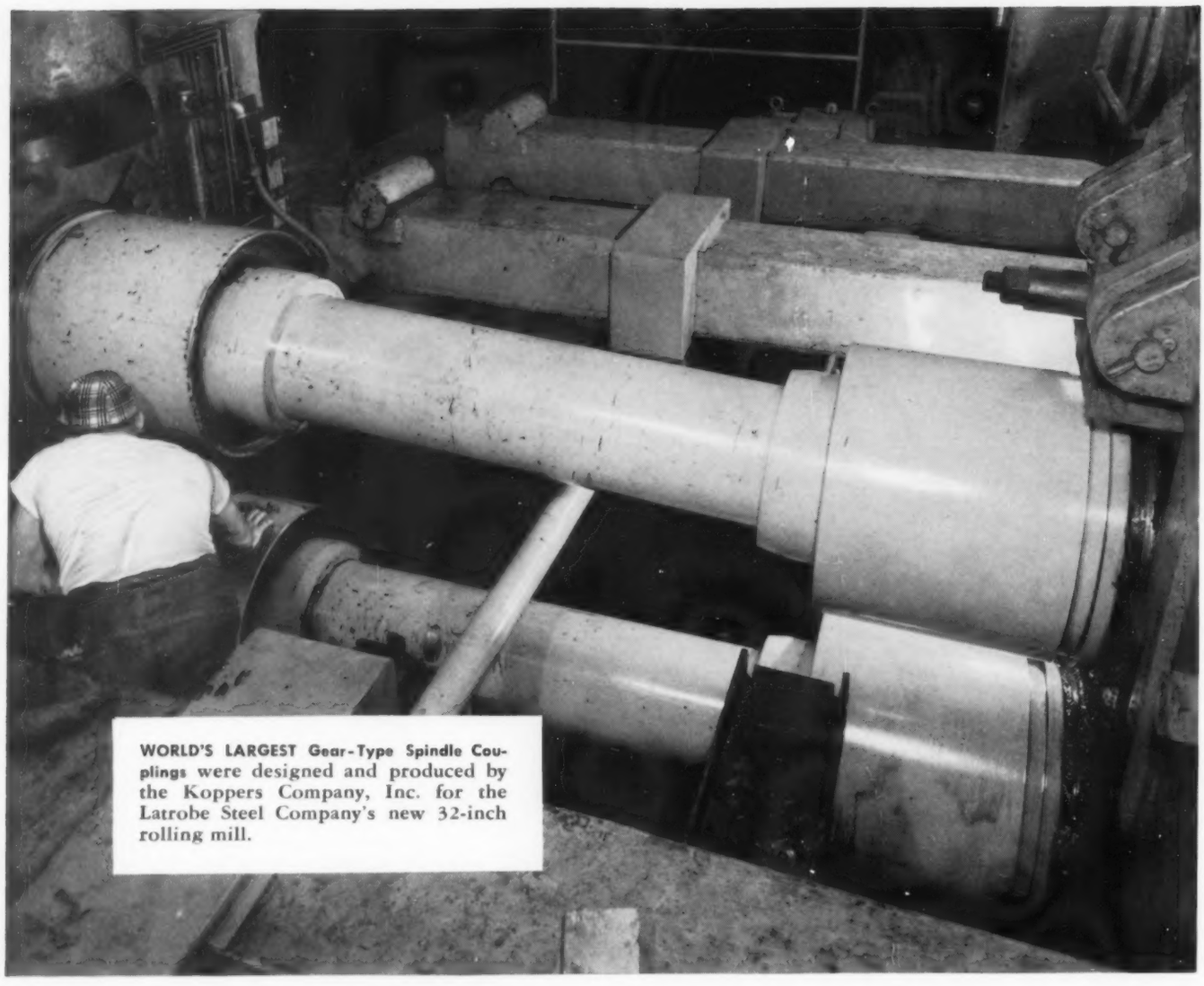

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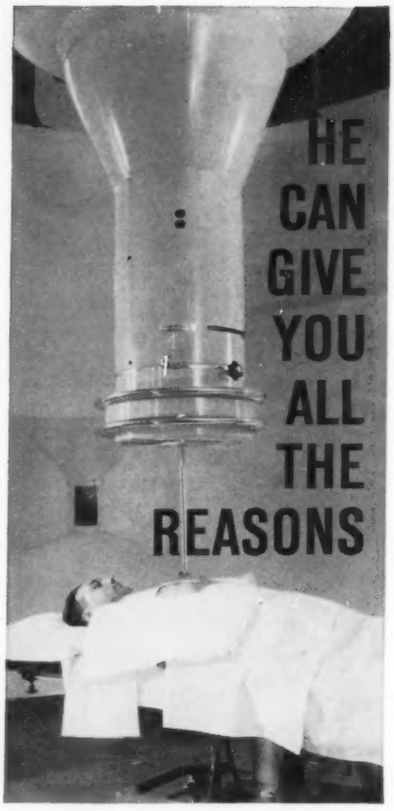
Book Reviews

(*Continued from page 230*)

of radioactivity are discussed. Tables, graphs, line drawings, and photographs supplement the text.

"Analysis of Straight-Line Data" by Forman S. Acton has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 267 pages, 6 x 9 in., is cloth bound, and sells for $9.00. The book covers the analysis of experimental data that can be described in terms of linear relationship with emphasis placed on the type of information to be extracted and the influence of the assumed statistical model on the success of the analysis. Short-cut computational techniques are stressed, and nonparametric and low-arithmetic techniques are brought together in a unified exposition. Theory has been included whenever helpful to encourage analytical thinking, and the philosophy underlying a method is frequently stressed to prevent diversion in mere manipulative detail. Line drawings, tables, and equations generously supplement the text. An appendix of tables of critical values, etc., is included.



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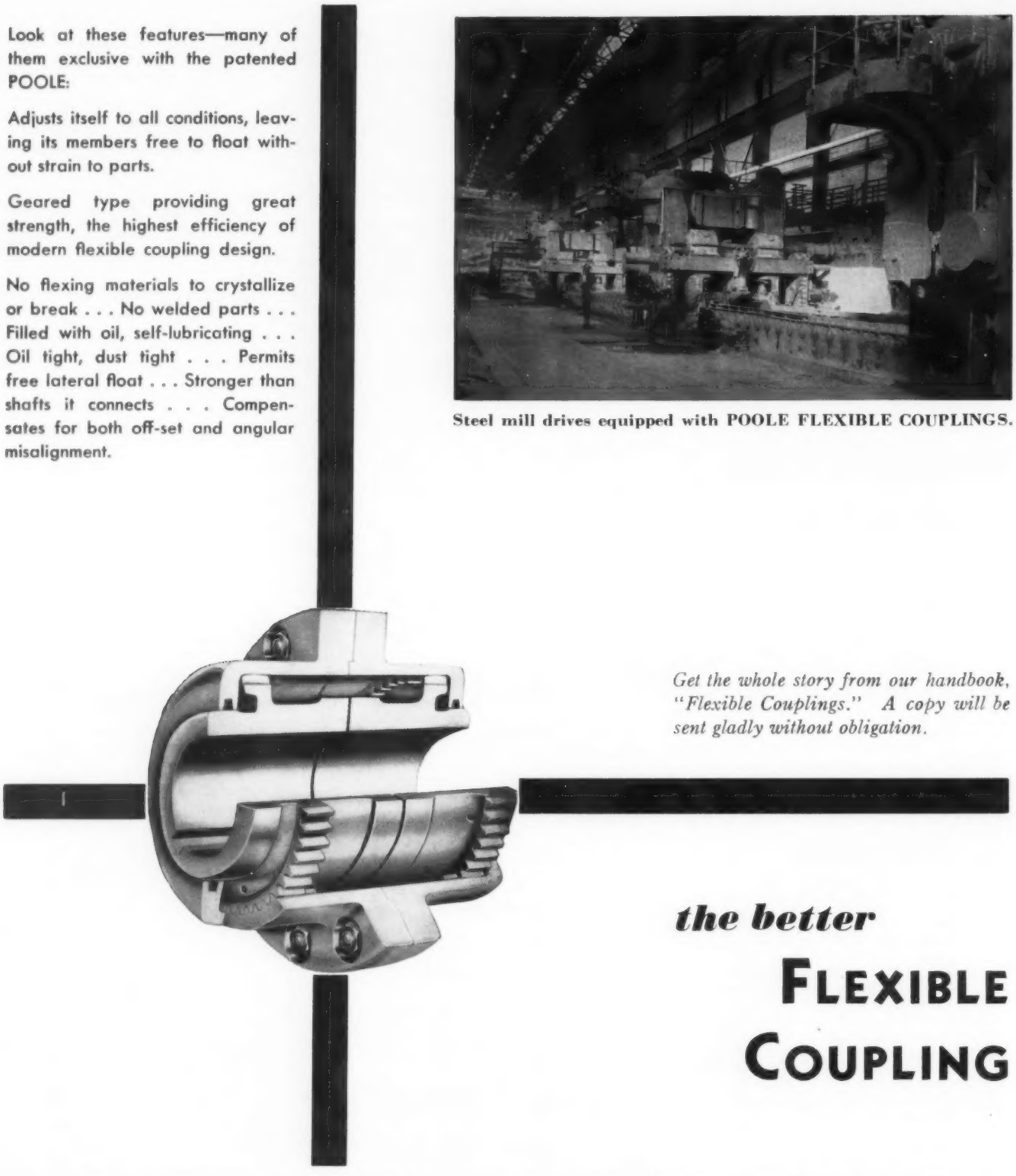

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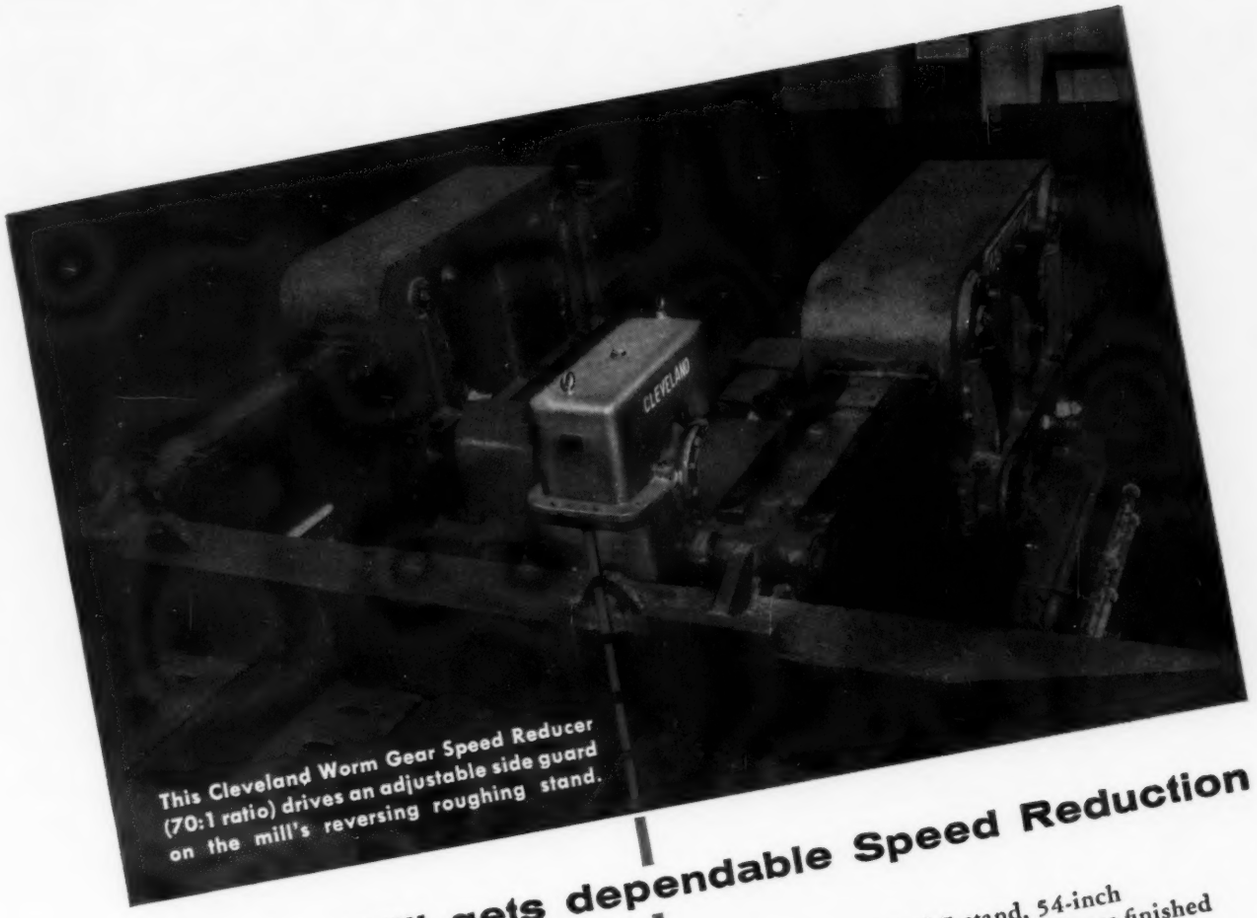

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